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The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

and

The Foundry Trades' Equipment and Supplies Association

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A Flexible System

The end of March marks a most important change in the situation respecting imports of iron and steel, the decision on which was taken by the Import Duties Advisory Committee on March 16. This restores the tariff rates operating up to July of last year, but which were reduced on account of the special conditions operating. These are well known in the trade, and manifested themselves in a threatened pig-iron and steel famine. These conditions have passed, and things are much easier, and hence the change. The actual rate varies. On so-called unlicensed imports, coming from countries outside the cartel or amounts in excess of the quota from cartel countries, it varies from one-fifth to one-third of the value, while it is only one-tenth on licensed imports, that is, where there is a cartel agreement. The reductions which have been in operation for some nine months brought down the rate to one-fortieth for licensed and to one-eighth for unlicensed imports. Even this failed to bring supplies, which went to markets where ruling prices were higher than in this country, until towards the end of 1937. Pig-iron remains on the free-list for the present.

The easier position in the industry does not necessarily herald the slump. We see no reason to depart from the view we have expressed that the tight position created in 1937 with regard to materials was due to overbuying at a time when makers had been running with greatly depleted stocks and were afraid of undue price rises. With the position stabilised for 1938 so far as iron and steel prices are concerned, the necessity for such action disappears, and stocks are again being reduced to normal. On the whole we think that 1938 should be only slightly below 1937 as a trading year, although the international position is disturbing some trades as much as it is doubtless assisting others. Conditions in the U.S.A. are another unsettling factor, but they seem to arise mainly from internal political conditions rather than from any real slump.

The action of the Import Duties Advisory Committee forms an interesting illustration of the flexibility with which our tariff system can be operated and its complete freedom from political control and jobbery which was at one time feared. It also does have genuine regard for the consumer both with respect to ensuring supplies and keeping prices at a reasonable level, for in the summer of last year free imports would not have brought supplies to this country, where prices were controlled to below the general world level.

The Proceedings

The 30th annual "Proceedings" of the Institute of British Foundrymen has just been distributed to the members, and it serves to emphasise the extremely wide scope of the Institute's activities. From a geographical aspect the contents include Papers by authors resident in Canada, France and Germany, whilst the future has every prospect in store of contributions from South African foundrymen. It is more than probable that Papers from the South African Branch will appeal to members resident in the other Dominions and Colonies as better portraying the kind of foundry practice suited to their needs than those emanating from the "old country."

The diversity of the subjects dealt with is well illustrated by the following analysis:—Grey-iron foundry practice pure and simple, two; non-ferrous foundry practice, six; costing, estimating and control, three; steel castings, three; sands and facings, three; phases of foundry metallurgy, two; melting plant, two; and one each on welding and coke and patternmaking. It might be thought that malleable foundry practice had been entirely neglected, but the two Papers on melting practice had special reference to this branch, whilst such features as patternmaking, coke, sands and facings make up an appropriate amount of technological reference matter for this section of industry.

The Presidential Address acts as corrective to the balance of the book, because with it the reader would imagine that here at least was a progressive industry in which practice and theory were well blended; where straight-line progress was being consolidated step by step, and where the future promised nothing other than the gradual attainment of perfection. This state of affairs is due to the fact that the "Proceedings" represents the work and views of the most enlightened firms and personnel of the industry, whereas Mr. Bigg took cognisance of those thousands of inarticulate and backward firms and individuals which in truth comprise the bulk. The Presidential Address is a salutary reminder that a serious effort has yet to be made to improve the general level of intelligence, related to technological, commercial and industrial outlook of the "unconverted majority" of the firms within the industry. Moreover, Mr. Bigg rightly insisted that it was the phases embraced by that overdone word "economic" which warranted prior and urgent consideration.

In its eight-hundred-odd pages, the "Proceedings" contains the cream of technological Papers presented during the last year and, with the earlier twenty-nine volumes, constitutes the best text-book on foundry practice published in the United Kingdom.

National Physical Laboratory

METALLURGICAL ADVANCES IN 1937

The main purpose of the National Physical Laboratory is to assist and advance British industry in the physical, electrical, engineering, metallurgical and shipping fields, and the Annual Report* for 1937, issued last week, presents the principal achievements during the year, and indicates the many ways in which the Laboratory can be of service to industry. Stress is laid on the assistance offered in overcoming manufacturing difficulties. Where desirable, members of the Laboratory staff will solve problems in manufacturers' works, or arrangements can be made for members of a firm's staff to work at the Laboratory and collaborate with the research workers there in cases where this offers an earlier solution of a problem. In many instances information which leads to the solution of a manufacturing difficulty can be provided without experimental work, and such information is supplied free of charge.

The Laboratory carries out its own wide programme of research with the object of advancing industry, and over 100 scientific and technical Papers giving the results of this work have been published during the year and are listed in the Report, which should repay the attention of industrial executives and technicians. Some of the results appertaining to the foundry industry are set out below.

X-Ray Research

Since the first crude photographs were taken by means of X-rays some 40 years ago, a huge volume of research on these rays has been carried out, and they are to-day of the highest importance both in medicine and industry. The Laboratory has taken an active part in both these branches of research. Thus, the work carried out at Teddington on the accurate measure of the dose of X-rays given to patients, and on the protection of X-ray operators from the rays produced at such high voltages as 400,000 volts, has received international adoption in 1937. As regards the value of X-ray research in industry, many industrial problems have been solved at the Laboratory by using X-ray methods of determining the arrangements of the atoms in a specimen of metal and the changes taking place in the atomic arrangement as a result of various heat and other treatments.

Measurement of High Temperatures

The importance of accurate measurements of temperature in industrial processes is obvious, and at the higher temperatures this is by no means an easy problem. The Report records large improvements made in the measurement of temperatures from about a red-heat to some 2,000 deg. Fah. Only a few years ago such temperatures could not be determined with a greater accuracy than 10 deg., and three years ago an accuracy of one-fifth of a degree was possible. More recent advances in instruments and technique now enable an accuracy of one-twentieth of a degree to be attained, which should suffice for all technical and scientific measurements for many years to come. These results are being applied to accurate determination of the temperature of liquid steel in furnaces, on behalf of an industrial body.

Light Alloys of Magnesium

The previous year's Report gave particulars of two important new series of magnesium alloys which had been developed at the Laboratory. Magnesium alloys are even lighter than those of aluminium, and their importance for use in the construction of aircraft is evident. During 1937 research has been carried out on the properties of these alloys under various kinds of heat-treatment, and it has been found that their strength can be considerably increased by forging them first at a high temperature, and then again at a lower temperature. Particularly good results have been obtained from the series of magnesium alloys containing some aluminium and a little silver.

Materials for Cast Crankshafts

A most interesting investigation into the properties of materials for cast crankshafts was brought to the report stage during the year. The use of cast materials for engine crankshafts is a modern and, to some extent, perhaps an unexpected development. Whereas the term "cast iron" formerly implied to the engineer a material low in tensile strength, with which a high factor of safety must be associated in the design of stressed parts, the modern application of scientific metallurgical principles of alloying and heat-treatment to cast ferrous alloys has resulted in materials capable of yielding strengths up to 60 tons per sq. in. Further, the crankshaft is essentially a component subjected to combined fatigue stresses, as to whose effects no reliable experimental data could be obtained, until the development, at the Laboratory, of a high-speed combined fatigue stress testing machine made this possible. The results obtained are not only of immediate value to the industry, but also appear likely to assist in awakening the interest of the engineer to the wide field of application now open to cast ferrous materials for general engineering purposes. The Institution of Mechanical Engineers has since initiated a general research into this subject, and arrangements have been made whereby the mechanical tests involved will be carried out in the Engineering Department of the Laboratory.

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Correspondence

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Ancient Chinese Castings

To the Editor of The Foundry Trade Journal.

Sir,—The letter from Prof. Read in the Journal for March 24 is a valuable addition to previous information. Actually I am glad to find his views are in agreement with mine. My theory was, and is, that the various discoveries connected with iron and steel have been made independently in many lands and in many ages. It is generally admitted that an advanced culture requires centuries of undisturbed occupation for its development, *e.g.*, the Sumerian, Cretan and Chinese civilisations.

Piracy, war, and occasionally trade or friendship, have enabled products to cross a frontier, without knowledge of the method of production. For example, Dr. Lardner (1832) briefly refers to Japanese sabres, and probably specimens reached Europe a hundred years before that, without any idea of how they were made, although such a specimen might be provocative of experiment to a thoughtful armourer.

The old firebacks in German museums appear to me to be representative of independent local invention, and in a sense are equally important as the wonderful Chinese castings made many centuries previously. Central Europe was for centuries (and is?) too disturbed for invention to flourish. It is deeply regrettable that further studies of Chinese castings will be impossible for many years, and it is surprising that visitors of the past failed to recognise many things unknown elsewhere.

With regard to the "flying scissors," I would like to venture the suggestion that they might have a symbolical meaning which only a Chinese scholar or philosopher could explain. However that may be, these Chinese castings are most remarkable, and we must be grateful to those who have given us the fruits of their examination of them.—Yours, etc.,

A. Allison.

Holmes Mills, Rotherham.
April 4, 1938.

Random Shots

A certain foundryman was experiencing difficulties in his foundry. He was working to capacity, but could not make profits. He called in experts to find out the cause. One said, "Mechanise your foundry. It's the only thing these days." Another advised him to call in the help of a costing expert. Another said, "Ah, what you want is an industrial psychology expert." At long last there came along a pal who poked about the cupola, asking searching questions. "That's where your trouble is, Old Man, production of iron too low." And because he was a pal and not an expert this desperate foundryman pricked up his ears. "First of all," said he, "you must use West Transport coke; that will save you 10 per cent. costs and give hotter iron." Having done that with considerable success, he called in his pal again. "Now," said he, "you must try the Corsalli process and save yet another 10 per cent. and give still hotter iron." Elated at the success of this experiment, and having got the idea, so to speak, he picked up The Foundry Trade Journal and read its pages over and over again. He decided to save another 10 per cent., making it now 30 per cent., by using special insulated bricks, by dosing with soda ash (40 per cent.), by changing the blowing system to the Sureman method (50 per cent.). Then he installed the balanced blast (60 per cent.), and the Poumay system (70 per cent.). He Emmelised (80 per cent.), Perlitised (90 per cent.) and Meehanitised (100 per cent.), and then, confident that he could produce really hot iron for nothing at all, went off for a golfing holiday. Next day, however, the foreman sent him a telegram: "Return at once. Iron spilling over charging door. Spoilt foundations for weighing machine on order."

* * *

It is a well-known but curious fact that at a foundry exhibition the last thing one expects to see is an exhibition of castings. Neither at the International Laundry Exhibition does one see much laundry. In fact, if you wish to see castings, the right place to go to is the Laundry Exhibition, though the reverse can hardly be said to apply! The week's washing these days is done by most elaborate machinery, in the construction of which castings are used extensively. The cynic would say, on the other hand, that the only place in which one would find the Ideal Home is at Olympia during the month of April!

* * *

As a visitor with a foundryman's outlook in life, "Marksman" was pleased to see at this exhibition that fine piece of statuary, Mr. Longden's "Runner," standing out as a striking symbol of human effort amidst a mass of mechanical power.

* * *

Laundryworkers, so long acquainted with the "sad-iron," turned naturally to the "glad-iron." (Thereby proving the benefits to be derived from a little practical application of industrial psychology?) A cool-looking Phyllis was calmly ironing one shirt every three minutes with this contrivance!

* * *

In extending good wishes to a member of the foundry industry, who has just celebrated his diamond wedding, one is reminded of the story of the host at a little dinner party to celebrate a similar occasion, who, with a tenderness amounting almost to reverence, passed the port to his guest. "Great stuff this port. Laid down the year of our marriage!" It was greatly to the credit of his guest, showing that he possessed great powers of tact, that he softly murmured, "That was a good year," and left it at that; for to elaborate on the theme of age and crustiness would without doubt have made his hostess's manner a little chilly and distant!

"Marksman."

Production of Pressure-Tight Castings

A PRACTICAL DISCUSSION

A wide range of subjects was introduced in the discussion on Mr. A. E. McRae Smith's Paper bearing the above title, following its presentation to the London Branch of the Institute of British Foundrymen. Very divergent opinions were expressed as to the desirability of top or bottom running for cylinders, the use of metallic additions to oil-sand cores, pouring temperatures and other germane topics. The Paper was printed in the JOURNAL for March 17, 1938.

Metallic Additions to Sand

The BRANCH-PRESIDENT (Dr. A. B. Everest) opened the discussion, and expressed appreciation of the very concise and practical Paper which Mr. McRae Smith had given. He referred to the practice he had heard of recently of mixing sand with cast-iron shot or other materials to produce a mixture which was in effect a chilling sand, and he asked whether the author had had experience of it and could indicate his views. It was appreciated, of course, that in order to secure pressure-tightness in castings of varying sections one endeavoured to equalise the cooling rates throughout those sections. In the case of a cylinder head, for instance, there was very often a lump right inside the casting, and in such cases it was usual to employ chills to accelerate the cooling in the thicker parts. Chills were always rather crude, however, and it seemed to him, from the theoretical point of view at least, that there should be possibilities in the use of sand mixtures which themselves acted as chills.

He would have thought that normally, when casting a liner with a flange at the end, one would wish to cast the flange down; but there was the argument that the metal must solidify from the bottom upwards. The author's theory ruled out the idea of hydraulic pressure acting to make sound a lump such as a flange.

As to the use of top runners for casting cylinder liners, he asked whether it was a practical proposition for casting a Diesel engine liner 10 ft. long; it seemed that the impact of the metal when it fell from the runners down the whole length of the casting must introduce some problems which needed careful consideration.

The author's remark that, for the production of high-duty cast irons, it was necessary to exercise careful control over the metal, led him to refer to cupola control and to ask why there were very wide variations in the foundries of this country in regard to cupola control. The foundrymen in the United States, he said, seemed to have their cupolas under much greater control than the foundrymen in this country, one reason being, he understood, that the raw materials used in America were poorer than ours, so that greater cupola control was necessary in order to ensure good results. He asked in what direction cupola control could be improved in this country, and what were the requirements for the production of high-duty cast irons.

Cast Iron Borings used in Cores

MR. MCRAE SMITH, replying to the question concerning the use of synthetic mixtures of sand and other materials for cores, said he had tried quite a number of them. He had not thought of using cast-iron shot, because it was not always easily available, but he had made synthetic core mixtures (in order to secure chilling properties) incorporating reasonably graded cast-iron borings and any one of the ordinary proprietary core oils of the linseed-oil base type. He had used such mixtures particularly for producing rather heavy couplings which had to be machined all over and from which feeding defects must be eliminated, and he would be interested to compare notes with others who had used them. The first reaction of a coremaker when such a mixture was suggested to him was to ask how he was going to rub it. If a core box were made properly, however, the core should not need rubbing. However, he believed the problem of using such mixtures could be pursued to great advantage. He was unable to give any real tips concerning their use, except to say that he had cast couplings, having bosses of about 7 in. metal thickness, with cores of only 3 in. diameter, incorporating cast-iron borings and a core oil of the linseed-oil base type, and those cores did not burn in; they were simply blacked over with plumbago or similar dressing in the ordinary way. Of course, he had always provided sufficient vent in the centre, and he suggested that in using such mixtures one should have a centre vent rather larger than would be used normally.

Casting Flanged Liners

The problem as to whether flanged liners should be cast with the flanges upwards was an extremely controversial one, but he suggested that the best results would be obtained far more often by the method suggested in the Paper than by other methods. One would expect that in casting a fairly long liner, the hydraulic pressure would be sufficient to feed the flange if it were at the bottom; but from practical experience he had found his method to be best.

The casting of a liner 10 ft. long was perhaps an extreme case, and presumably the Branch-President, when referring to that, had had in mind a liner of very considerable sectional thickness. In his opinion, it should be possible to reinforce the mould structure at the bottom in such a way that the metal could be dropped right down without causing difficulty, even if it were 20 ft. deep. In one small foundry in London, which had not the facilities that many others had and which might not be regarded as being very highly controlled, the specialities were hydraulic cylinders and rams, the cylinders being very often 18 or 20 ft. long, and the metal was dropped for that distance without any hesitation whatsoever.

Cupola Standardisation

He felt very strongly about the enormous variations which existed between cupolas of different design. With reference to heights, one would provide 8 ft. from the centre line of the tuyeres or the top of the tuyeres to the charging door, and another would provide perhaps 18 ft. Tuyere ratios varied enormously, and there were sometimes differences in the neighbourhood of 300 per cent. as between one cupola and another. Without attempting to give his own ideas as to the optimum conditions, he urged that it was quite wrong to have such wide divergences between the different designs of cupolas which were supposed to give the same tonnage of metal per hour. Designers of crucible furnaces would never think of such enormous variations as were found between cupolas.

Balancing Silicon Content with Section

MR. BIRD put the case of two charges of cylinder metal containing, say, a refined iron with 1.9 per cent. silicon, for casting cylinders of ½-in. wall thickness, and asked how the author would soften that metal in order to cast a cylinder with a projection of ¼-in. section, without reducing the fluidity of the metal. He also asked whether a copper addition would be suitable, or whether it would have any effect on the porosity of the casting. He added that, at his foundry, liners of about 30 cwts. were cast with the flanges down, and they were quite sound.

MR. MCRAE SMITH said he imagined Mr. Bird had to deal with circumstances which rendered it necessary to use rather small quantities of metal. The natural thing to do would be to put into the cupola another and softer mixture, having a higher silicon content; but he imagined that an iron with 1.9 per cent. silicon should be soft enough to cast a ¼-in. section. However, he could add ferro-silicon to the ladle, and could also add nickel.

With regard to the casting of the 30-cwt. liners with the flange downwards, he said it was necessary to use denseners with a view to securing soundness; that, of course, was another method of casting a flanged liner where the flange was of greater thickness than the body of the liner, but it was a method which showed weakness. After all, it was better to cast without using denseners, if possible, because the use of denseners always involved the risk of blowing, and so on. He preferred the safety-first method.

Mould Strength and Weakness

MR. C. H. KAIN (Past Branch-President), commenting on the author's reference to defects which might arise from the weakness of a mould, and the suggestion that such defects ought to be overcome by suitably strengthening the mould, said that, particularly when casting high-strength irons, defects were more likely to arise as the result of the strength of the mould than as the result of its weakness. There were more waster castings made as the result of using too hard or too strong a mould than from using too weak a mould.

As to the statement in the Paper that the selection of the correct method of moulding (gating and feeding) allowed a wide choice of metal composition, he suggested that the selection of the correct metal composition or mixture would allow much greater latitude in methods of moulding and would enable one to produce a sound casting more easily than would be the case if a less suitable metal composition were selected.

In asking the author to enlarge upon his references to casting temperature, Mr. Kain said it was a subject which was very widely discussed, but there were no really authoritative pronouncements with regard to it. For producing pressure castings he always preferred to use the highest possible casting temperature, usually in the face of great opposition from the foundry foreman.

With regard to the author's statement that many of the inoculated irons were easily castable, Mr. Kain said he had not had experience of an inoculated iron which was easily castable. In every case within his experience such irons appeared to require very great care in casting and in the selection of methods of gating and feeding.

MR. MCRAE SMITH pointed out that when he had referred to defects due to weakness of mould he had not meant to imply that the mould should be as strong as though it were made of concrete; indeed, he had emphasised that the mould should possess the requisite degree of permeability. The first essential of a mould for the casting of high-quality iron or pressure-tight castings was that it should be sufficiently permeable to allow all the gas to get away during casting. He did not think it was impossible to arrive at the requisite compromise, *i.e.*, a mould having a structure which afforded the necessary strength or refractoriness, and at the same time a suitable permeability.

MR. KAIN said he was thinking of the problem of avoiding tears; the difficulty of overcoming tears or cracks in high-duty iron approached that experienced in the steel foundry.

MR. MCRAE SMITH said he appreciated that point. He was speaking of pressure-tight irons and was trying to keep off the subject of high-duty irons. But in the Paper he had mentioned the contractibility of moulds and cores, which overcame the trouble of tears.

As to Mr. Kain's preference for arriving at the correct mixtures of metals in order to give wider latitude in moulding methods, rather than selecting the best methods of moulding and

thereby allowing a wider choice of metal composition, he said there was really nothing in it either way. His own feeling was, however, that it was easier to adopt a moulding practice which would give a little more latitude in regard to the metal composition.

Expressing entire agreement with Mr. Kain's remarks concerning casting temperature, he said that the straight silicon-carbon irons or the common irons used to-day could not be cast too hot. That did not apply, however, to the austenitic cast irons. He had recently discussed the matter with three foundry foremen, whose ages were 65, 70 and 71 years respectively, and he was well aware of the difficulty of making them appreciate that the moulds should be able to withstand the high temperatures satisfactorily.

The question raised with regard to casting inoculated irons was a very difficult one. His contention was that cast irons of the high-tensile type were reasonably easily castable; he had little experience of other inoculated irons, however. After all, there were always certain difficulties in casting metal, and it was well to be sure of what was meant by the term "ease of castability."

Ronceray Runners

Mr. G. C. Pierce (Past Branch-President) asked whether the author had ever applied the theory of Ronceray to the production of his pressure-tight castings. The methods discussed in the Paper were absolutely different from those of Ronceray and his use of risers, headers and so on.

Mr. McRae Smith said he was glad that Mr. Pierce had raised that matter because it enabled him to give an explanation which would avoid any misunderstanding. The Ronceray runners were still used successfully, and he himself used them extensively, but in practical details the Ronceray runners were slow running and of the top running type, and were not for bottom running. He referred to some liners he had cast recently by using runners on the Ronceray principle, *i.e.*, by having a ring around the top of the head and runners of $\frac{1}{4}$ in. or $\frac{3}{8}$ in. diameter. In making a fairly lumpy casting of about 10 in. diameter and probably 10 in. depth the usual method was to provide an inch machining on the top and to use three very small Ronceray runners. It was the principle of gradation of solidification; the metal was run on top very slowly and the casting was feeding itself as it solidified.

Piston Production

Mr. Spencer, who was interested particularly in the production of Diesel pistons and liners, expressed his thanks to Mr. McRae Smith for the assistance he had given in regard to the production of pistons. The method of casting with the heavy section head had proved itself. There had been solidification contraction previously on the outer walls and in the centre of Diesel pistons weighing approximately 1 ton, but by increasing the head and using a "V"-shaped riser, that difficulty had been overcome. Shortly his foundry would be making a 4-ton piston for an installation on a big boat and he was fairly sure that it would be really solid. He had no doubt that the heavy section should be cast at the top.

Discussing inoculated irons, he said that in casting small cylinders and pistons weighing up to 2 or 3 cwts. in the calcium-silicide inoculated iron, he found that whenever the phosphorus content was more than 0.3 per cent., there was porosity at any change of section, however small that change.

He asked whether it was advisable for casting pressure-tight castings to use a steel mix or to use an iron with a high combined carbon content to start with; in other words, should one use a mix which contained no steel or only a very small amount of steel, or should one start with a high combined carbon pig-iron? As to the life of pressure-tight castings, particularly pistons, he asked whether an iron of low carbon content and tight grain and finely distributed graphite was found to be more serviceable than an iron with a fairly high combined carbon content and a tight grain.

Compositional Considerations

Mr. McRae Smith said that he had not sufficient experience of the influence of the phosphorus content of inoculated irons to enable him to discuss the matter. The question as to whether one should use high steel-mix irons or, conversely, irons with high combined carbon content, depended upon the conditions and upon the aim of the foundrymen concerned. If one preferred to use lower percentages of steel scrap in cupola iron—something between 15 and 30 per cent.—he was in favour of using non-graphitic cast iron, *i.e.*, white or mottled iron, as the basis of the mixture. If, on the other hand, one had the experience and control over a particular cupola which would render it advantageous to use high steel-mix cast iron, he was in favour of that.

He was not prepared to give a definite opinion as to whether a high or a low combined carbon iron gave the better service generally. The service given by an iron depended entirely upon its structure, and there were so many structures produced that it was very dangerous to attempt to give a general answer to the question.

Pouring Temperature Control

Mr. Philip Russell, B.Sc. (Past-President, East Midlands Branch), joined issue with the author in regard to pouring temperatures, and at the risk of being regarded as a heretic, he said he believed it was possible to pour a casting unnecessarily hot. The author had said that it was necessary to produce a mould which would withstand pouring at any temperature, and at the same time he had said that the method of moulding should be determined on the basis of purely economic considerations. But surely it was not economical always to produce moulds to withstand pouring at any temperature, if the metal were not to be poured at a very high temperature, and he emphasised his belief that for each class of iron and each class of casting there was a minimum pouring temperature which it was not necessary to exceed. Unfortunately, we did not know what that minimum was in each case, but it was often much higher than the foundry foreman liked. Given first-class cupola practice and good superheat it was not necessary to pour the iron immediately it came from the cupola. In his view one could not melt the iron to too high a temperature, but one could afford to allow it to cool down a little before pouring certain types of castings.

Metal-Sand Cores Unsatisfactory

His experience of the use of cast-iron borings in sand mixtures with a view to producing the chilling effect had been very sad, and he had concluded that the borings oxidised during the drying process and a large volume of gas was evolved, which resulted in blowing. The resulting castings would have made very good match strikers, but otherwise they were not of very much use!

In asking for opinions with regard to feeding *via* the runners, he said the author had indicated that the runners should be distributed and that the feeders should be placed at the heavy part of the casting, at the top. In certain designs, however, it was usual to combine the feeding with the runner, by means of a basin placed above the top of the runner. In that case it was necessary to use a larger ingate than usual, and to resort to straining in order to prevent slag going into the casting.

The advocacy of making castings with the heavy parts at the top of the mould represented a complete change from text-book foundry work, and he endorsed the author's remarks concerning casting with the heavy parts at the top, provided they were adequately fed. If they were not adequately fed, it was better to have the heavy parts at the bottom and to rely on static pressure.

Commenting upon the point raised concerning the castability of inoculated irons, he agreed with the author that irons of the high-tensile type were easily castable, provided the castings had not very large lumps which called for the use of special feeding arrangements. They were almost as easy to run as a phosphoric iron.

High Pouring Temperatures Advocated

Mr. McRae Smith said he still maintained that high pouring temperatures were ideal—and by "high pouring temperatures" he meant temperatures in the region of 1,450 and 1,500 deg. C. The higher the pouring temperature, of course, the slower the rate of cooling and the longer the cooling period, but the metal composition should take care of that. He was willing to compromise by agreeing that where a job could only be economically produced by using a green-sand mould, such a mould could be used and the casting should be poured at the highest temperature the mould would stand. Such problems must be dealt with sensibly, of course. But where it was possible to use a mould in a condition in which it would withstand the highest pouring temperature, he favoured it, particularly where one was moulding a pressure-tight casting and was using feeding heads.

Cast-Iron Borings in Cores

Perhaps he had been lucky in his use of cast-iron borings in synthetic sand mixtures for cores, but he had not experienced the difficulty referred to by Mr. Russell. His method was to ram the cores and to black them before drying, and then to give them a second blacking after drying; he was agreeably surprised to find that the cast-iron borings had served the purpose intended. He asked whether the borings used by Mr. Russell were absolutely fresh, or whether it was likely that they had rusted a little.

Mr. Russell said his recollection was that they were fresh, but that a certain proportion of sand was mixed with them.

Mr. McRae Smith said that the borings he had used had contained no sand whatever, and he had been careful to ensure that they contained no rusty borings.

The making of flat lumpy castings was a difficult proposition, and it was sometimes satisfactory to feed via the runner. In producing a flat cylindrical casting his practice was to use a few small runners, and to put a heavy "off" riser on the other side and feed that. But he was not keen on feeding down the actual runner, and preferred to feed at the opposite side of the casting or in a diagonally opposed position.

Making Pressure Castings

Mr. A. R. Bartlett (Past Branch-President) said it was his experience that, for pressure casting, the higher the pouring temperature the better; he would also avoid chills wherever possible and apply pressure by means of feeding heads or risers. He had found it best to incorporate the runners and risers as part of the pattern, especially for castings such as liners. Having made many hydraulic liners and cylinders and ordinary steam cylinders up to 20 ft. long, he had found invariably that the best results were obtained by dropping the metal from the top. Of course, the cores and the mould must be right. He disagreed that a liner should be cast with the flange at the bottom, involving the use of chills, and urged that the flange should be at the top, with a pressure head on it to counteract any tendency to drawing. The metal had to drop a considerable distance, and he had found it necessary to reinforce the mould face by using a certain percentage of fireclay in the sand. There must be ample provision for venting between the brickwork, however. In the casting of couplings he had used cores incor-

porating iron borings, and had used a small percentage of silica sand in the cores as well. He agreed that a large vent must be provided. When using chills for making couplings he had always found some sort of trouble arising around the core. In his experience, the best course was to run with a thin runner, perhaps halfway round on one side, with a riser on the opposite side, and to feed down heavy risers as close as possible to the casting.

Mr. McRae Smith said that in his early days in the foundry it was very annoying to be presented with a drawing which gave no indication as to whether the casting had to withstand a pressure of 10 or 1,000 lbs. per sq. in., and he appealed to all engineering and foundry executives to ensure that information of that sort was contained on the drawings.

Mr. Bartlett added that he personally obtained all the information he required, but he had met friends who had said that they had not been given sufficient information at the commencement of a job.

Good Results from Metal-Sand Cores

Mr. J. H. King asked whether the same principles of top running applied to a non-ferrous liner as to an iron liner. With regard to the use of chill cores at flanges, he said that during the last few years he had used steel shot in the cores, with excellent results; indeed, the results were so good in the case of castings which had to withstand pressures between 2,000 and 3,000 lbs. per sq. in. that the use of those cores had become the standard practice. The venting of large cores was provided for by using a large body of coke ashes. Contrary to the author's practice of blacking the cores before drying them, he said he had found it best to dry the cores immediately they came from the core box, to rub them with a dry rag in the morning and then to black them. They produced an excellent skin on the castings.

Application to Non-Ferrous Metals

Mr. McRae Smith replied that he did not think one could draw any comparisons between liners made in non-ferrous metals and those made in any type of cast iron. His experience of non-ferrous metals was concerned particularly with brasses, gunmetal, manganese-bronze, and so forth, and they presented a proposition entirely different from that of iron. For manganese-bronze one must have a feeding head. If he had to cast a manganese-bronze liner with a heavy flange he would certainly cast it with the flange upwards, and would take precautions in regard to the running to ensure that the metal rose properly from the bottom, because any turbulence must be avoided in running alloys of that type.

Mr. King said that when referring to non-ferrous metals he had had in mind a straight gunmetal, for instance, and not the high-tensile brasses or manganese-bronzes.

Mr. McRae Smith said that he had often cast a straight gunmetal by means of bottom running; but the conditions there also were very different from those applying to iron, and there were fears of oxidation, and so on, occurring.

Bottom Running and Metal Temperature

Mr. A. J. Murphy, commenting on the references to the desirability of attaining a very high pouring temperature for iron, said he suspected that Mr. Russell had put his finger on the true factor in distinguishing between the effect of superheating and the effect of pouring temperature, and he asked for the author's views as to the reason why a high pouring temperature was desirable for casting iron which was required to withstand high pressure.

The references to the effects of bottom running illustrated that the foundry industry was perhaps neglecting some lines of investigation that it ought to follow up. It might seem obvious that when metal was poured into the bottom of a vertical cylinder, the metal at the bottom was hotter than the metal at the top at the moment when the mould was full, but he believed there was evidence to show that that was not necessarily true. It was quite possible, given the right orientation of ingates, for the incoming hot metal, at the time the mould was half full, to go straight through to the top, but that state of affairs could be altered completely if the direction of the flow of metal through the ingates was not correct. The matter was one which could be investigated by fairly simple experiment; such experiments as had been made contradicted what most people accepted as an axiom —that bottom pouring always placed the hottest metal at the bottom instead of at the top.

Mr. McRae Smith said he appreciated the distinction between high pouring temperature and superheating, and he agreed that one should certainly melt the metal as hot as possible and have all the superheat that could be obtained. It was also his opinion—and he emphasised that he was expressing a purely personal opinion—that it was best to pour at a high temperature, not so much on metallurgical grounds as on mechanical grounds. Hot pouring gave a cleaner job, the metal was much more fluid than when poured at a lower temperature (it was largely a question of viscosity) and would take everything up with it. It must be borne in mind that high pouring temperature and high melting temperature were two distinct factors, with two entirely different objects in view.

Whilst he would not dispute Mr. Murphy's theory that bottom pouring could be effected in such a way that the hottest metal was at the top of the casting as soon as the mould was filled, he still believed that top running was better, if one aggregated all the circumstances entering into the problem, which included matters such as the conductivity of the mould material.

Carbon-Silicon Ratio

Mr. J. H. Williams, who commented that the author had mentioned silicon as being *the* factor in regard to sectional thickness of casting, and at a later stage had mentioned carbon also, said he believed it had become well known that carbon plus silicon constituted an important factor to be taken into account in a pressure-tight cast iron. The ratio between those two elements had not been stated clearly in the Paper, and he had gathered from the author's remarks that with high carbon there should be very low silicon content, and *vice versa*. But he believed there was an optimum ratio for carbon and silicon.

With regard to the use of silver pig, *i.e.*, hard iron mixed with ordinary grey pig-iron, for making castings, he said that that problem was coupled with the problem of blast pressure, and he suggested that insufficient attention was paid in this country to the blast that was used in cupola melting. Lately some firms were installing blast meters, etc., on the cupolas; but until very recently, blast pressures had generally been badly neglected. From experiments he had made he could prove that it was quite an important factor. Some people had gained some advantage by using silver pig in contra-distinction to a steel mix; but quite recently he had been responsible for making a number of castings in which a "steel pig" was used, and others in which an ordinary steel mix was used instead, and had found that if care were used in the working of the cupola the results were identical. The castings were for pressure work and their tensile strength was moderately high (18.5 to 21 tons per sq. in.); and the metal contained about 1½ per cent. of nickel. But the point was that quite good results could be obtained with a straight iron or a steel mix, provided the blast pressure was properly adjusted.

Expressing agreement with the author's remarks concerning top pouring, he asked for his views as to the rate at which the metal should be poured. In Germany recently he had found that much attention was being devoted to the rate at which the metal was poured into the casting, and in all cases the castings were top poured.

Silvery Pig-Iron

Mr. McRae Smith agreed that carbon plus silicon constituted a very important factor in relation to the thickness of section of a casting, and that there was certainly an optimum ratio of those two elements. The optimum carbon/silicon ratio was the basis of the Lanz Perlit iron process, but he had not dealt with that subject in the Paper.

Apparently Mr. Williams and himself were at cross purposes with regard to the use of silvery pig-iron. In the Paper he had mentioned silvery pig-iron in connection with mixes containing very high percentages of steel and perhaps 10 or 15 per cent. of silvery pig-iron, the term "silvery pig-iron" meaning high-silicon pig-iron. It was his opinion that most cupolas in this country were run at too high a blast pressure.

Rate of pouring was an important matter, of course, and should be correlated with the weight, type and size of casting. It depended very largely on surface areas, core areas, and so forth. Very often it was necessary to accelerate the pouring operation, using larger ingates than normally, on account of surface friction and surface cooling.

Mr. M. Benbow said the author had rather suggested that there might be some better and more scientific means than the cupola for melting cast iron. Would he go so far as to say that the cupola was obsolete?

Mr. McRae Smith replied that this question was very pertinent. He answered it by pointing out that every public-house in London would like to instal a refrigeration system to cool their beer, but it would cost about £250 per eleven-barrel installation, and, therefore, it could not be done all at once.

Vote of Thanks

Mr. C. H. Kain (Past Branch-President), proposing a hearty vote of thanks to Mr. McRae Smith for his Paper, said that, unlike most technical men, he did not lose sight of the primary object of the founder, which was, after all, to make money. He had stated in the Paper, for example, that the first object was to make a casting which would sell at the best possible price and which involved the least possible expenditure of labour and materials. If technical people bore that in mind more frequently, some of the rather wild statements that one heard from time to time would not be made at all.

Mr. Williams, seconding, said the Paper had been interesting and instructive. But he was rather sorry that the author had confined it to general matters, having regard to the ingenuity he was known to have exercised from time to time in overcoming some very difficult problems.

The vote of thanks was accorded with acclamation.

Low Moor Blast Furnaces

It has been decided by the Low Moor Iron Company, Limited, to discontinue the manufacture of cold-blast and special pig-irons at Low Moor, Bradford, and the whole of the works, including the land, has been acquired by Thos. W. Ward, Limited, of Sheffield, for breaking up. The goodwill of the company, the brand, and the stocks of pig-iron are still retained by the Low Moor Iron Company, Limited. This acquisition adds a considerable acreage to the already large area owned by Thos. W. Ward at Low Moor, and it is being developed as a trading estate. The Low Moor Iron Company, Limited, has no connection with the rolling mills manufacturing best Yorkshire iron at Low Moor, and owned by Low Moor Best Yorkshire Iron, Limited.

Iron and Steel Institute

ANNUAL MEETING AND SYMPOSIUM ON STEELMAKING

The Annual Meeting of the Institute will take place, by kind permission, at the Institution of Civil Engineers, Great George Street, Westminster, on Wednesday, Thursday and Friday, May 4, 5, and 6, 1938, commencing each day at 10 a.m. In conjunction with this meeting, as previously announced in our columns, a Symposium on Steelmaking, with special reference to acid and basic open-hearth practice, will be held. Twenty-one Papers descriptive of the plant and practice at representative steelworks in the principal steelmaking districts of Great Britain will be read and discussed, as well as a Paper on the metallurgy and physical chemistry of steelmaking in the acid and basic open-hearth furnace, and one on the correlation of British open-hearth data.

We append details of the programme of proceedings:—

Wednesday, May 4.

10 a.m.—General meeting of members; presentation of annual report and statement of accounts for 1937; election of new members and associates; induction of the newly-elected President, the Right Hon. the Earl of Dudley, M.C., into the chair; presentation of the Bessemer gold medal for 1938 to Dr. C. H. Desch, F.R.S.; announcement of the award of the Andrew Carnegie Gold Medal for 1937, and presentation of the medal; presentation of the Williams Prize for 1937 to Mr. W. Geary; Presidential Address; presentation and discussion of Papers contributed to the Symposium on Steelmaking.

2.30.—*Afternoon Session.*—Symposium on Steelmaking (continued).

Thursday, May 5.

The whole of this day will be devoted to the further discussion of Papers contributed to the Symposium on Steelmaking.

The annual dinner will be held at Grosvenor House, Park Lane, London, W.1, at 7 for 7.30 p.m.

Friday, May 6.

10 a.m.—Presentation of the following Special Report and Papers for discussion:—Special Report No. 20; Paper No. 3; Paper No. 5.

2.30 p.m.—*Afternoon Session.*

Presentation of the following Papers for discussion:—Nos. 2 and 9; and formal presentation of Special Report No. 21.

List of Papers

The following is a complete list of the Papers offered for the meeting:—

Special Report No. 20.—"The Application of Time Study to Rolling Mills." By the Rolling Mill Committee of the Iron and Steel Industrial Research Council.

Special Report No. 21.—"The Fifth Report of the Corrosion Committee." By a Joint Committee of the Iron and Steel Institute and the British Iron and Steel Federation.

Paper No. 1.—"Comparison of the Tensile Deformation Characteristics of Alloys at Elevated Temperatures." C. R. Austin and H. D. Nickol.

No. 2.—"An Experimental Inquiry into the Interactions of Gases and Ore in the Blast Furnace. Part V.—The Influences of Hydrogen and Steam at 450—850 deg. C." W. A. Bone, F.R.S., H. L. Saunders and H. J. Tress.

No. 3.—"Influence of Composition and Treatment on the Rate of Acid Attack on Mild Steel." C. A. Edwards, F.R.S., D. Luther Phillips and D. F. G. Thomas.

No. 4.—"The Effect of Copper on Some Alloy Steels." R. Harrison.

No. 5.—"Martensitic Grains in Rapidly-Cooled Ingot Iron and Mild Steel." B. Jones and N. Gray.

No. 6.—"The Effect of Chromium and Carbon Contents on the Coefficients of Thermal Expansion of Chromium Steels." J. A. Jones and W. C. Heselwood.

No. 7.—"Solidification in Open-Topped and Closed-Topped Ingot Moulds." B. Matuschka.

No. 8.—"The Exact Quantitative Estimation of Ferric Oxide and Sulphide Sulphur in Basic Slags." E. Maurer and F. Haderer.

No. 9.—"The Atmospheric Corrosion of Galvanised Iron Wire and Its Bearing on Specification Testing." C. E. Richards.

List of Papers Contributed to the Symposium on Steelmaking

Glasgow District.

"Basic Open-Hearth Practice in Scotland," by J. G. Fairgrieve and J. Gibson.

"Manufacture of Plain Carbon Acid Steels," by J. M. Ferguson.

"Some Aspects of Slag Control in Melting Practice," by R. Hay, J. M. Ferguson and J. White.

Lancashire District.

"Open-Hearth Steelmaking as Practised at the Irlam Works of the Lancashire Steel Corporation, Limited," by J. Sinclair Kerr, J. V. Morgan, W. Goldsbrough and D. Binnie.

"The Barrow Hematite Steel Company, Limited," by J. W. Danks and V. W. Davidson.

Lincolnshire District.

"The Steel Plants of the Frodingham District, Scunthorpe," by J. B. R. Brooke, S. R. Isaac and A. Robinson.

"The Appleby-Frodingham Steel Company's Melting Shops," by A. Robinson.

"John Lysaght, Limited, Normanby Park Steel Works, Scunthorpe," by J. B. R. Brooke.

"The Redbourn Works Melting Shop of Richard Thomas & Company, Limited," by S. R. Isaac.

North-East Coast District.

"Acid and Basic Open-Hearth Practice on the North-East Coast," by Frank Bainbridge, W. Geary, James Winter and P. W. Wood.

"Practice at the Works of the South Durham Steel & Iron Company, Limited, and Cargo Fleet Iron Company, Limited," by James Winter.

"Open-Hearth Acid and Basic Processes at Consett," by P. W. Wood.

"Plant and Practice at Works of Dorman, Long & Company, Limited," by W. Geary, L. E. Crooks and E. Drewery.

"The Melting Shop of the Skinningrove Iron Company, Limited," by Frank Bainbridge.

Sheffield District.

"Acid Siemens Open-Hearth Process," by E. Dawtry, W. H. Hatfield, F.R.S., and C. W. Wright.

"Making Basic Open-Hearth Steel for Many Purposes," by R. Percival Smith.

"Basic Open-Hearth Steelmaking Practice of the Park Gate Iron & Steel Company, Limited, Rotherham," by R. T. Lintern and R. A. Hacking.

"Some Experiences in the Design and Control of Open-Hearth Furnaces," by R. J. Sarjant and E. J. Barnes.

"Steelworks' Refractories," by T. Swinden and J. H. Chesters.

South Wales District.

"The Mixed-Gas Melting Shop of Guest, Keen & Baldwins, East Moors, Cardiff," by James A. Davies.

"A Tilting Furnace Fired with Cold Coke-Oven Gas," by R. W. Evans.

The Physical Chemistry of Steelmaking.

"The Application of Physical Chemistry to Steelmaking," by A. McCance.

Correlation of British Open-Hearth Data.

"Open-Hearth Data and their Correlation," by the Open-Hearth Committee of the Iron and Steel Industrial Research Council.

Bibliography.

"Bibliography on the Physical Chemistry of the Open-Hearth Process. (Covering the period 1920 to 1937.)" Prepared by the Library and Information Department of the Iron and Steel Institute.

The Copper Situation

By "Onlooker."

If copper has done nothing else it has achieved a measure of stability of late, for in the States 10 cents has been maintained on the domestic market, while in London standard has kept fairly close to £40, with electro standing at a mean figure of about £43. On the Metal Exchange, turnovers have been small and dealing in consequence narrow, so that price movements have frequently been out of relation to the amount of business done in the open market.

Perhaps the feature of the situation is the absence of selling pressure, and this is rather extraordinary when one considers that world stocks have now climbed beyond half a million tons and are still increasing. The upward movement is confined almost entirely to the U.S.A., for in the extra-American countries production is only slightly above consumption and the rate of increase in stocks is not at all serious. In this country, at any rate, reserves of copper seem to have reached stability.

Sterilised Stocks

Reference has already been made to the lack of selling pressure in London, and since consumption in the States is apparently running at less than 30,000 short tons per month, it is rather remarkable that advantage is not taken of the London market to hedge against this holding. Some people are fearing that shipment will be made later in the year, and unless conditions improve in America the producers may decide to send copper across the Atlantic. This would certainly bring about a setback in sterling values, for confidence would be seriously impaired and one can imagine even a break-up of the existing arrangement, for the "Cartel" producers would be seriously inconvenienced—to put it mildly.

The apparent immobility of stocks is one of the major puzzles in the copper situation just now, and the theory has been advanced that large blocks of this tonnage have been earmarked by various governments for their war chests. The suggestion is certainly quite tenable, but as far as this country is concerned nothing definite is known about the Government's plans. As to invisible stocks, these are probably fairly heavy, for although consumers are supposed to have been drawing on the reserves they accumulated last year there seems to be a good deal of metal in storage apart from official warehouses.

What does the immediate future hold in store for copper? In the first place one can say with a good deal of certainty that, although consumption may decline a little further yet, and the grand total for this year fall below the remarkable figure returned for 1937, nevertheless things are going on well. This applies especially to the position outside the United States, for Japan and Russia, and particularly the latter, are taking huge quantities; in fact, it is not too much to say that had it not been for buying by Russia the price of copper to-day on the London market would have been much lower than it is. How are matters going to develop in America? There now appears to be rather a rising tendency in the rate of deliveries, which nevertheless remain at only about half what they were last year. In the opinion of the writer, however, this improvement will not go much further at present, and it looks like being late summer or early autumn before a real uplift occurs. That producers are endeavouring to hold the price at 10 cents cannot be doubted, and so far enough business has been found to keep the custom smelters from price cutting. The summer months may, however, well bring quieter conditions, and in spite of demand for armaments, which, as it happens, is checking to some extent commercial interest, one cannot help feeling that copper is destined for a lower price level.

Some Points on Non-Ferrous Foundry Practice

By A. PHILLIPS

(*Continued from page 273.*)

ALUMINIUM ALLOYS

Aluminium alloy castings can be placed into three classes:—(1) Castings used as cast; (2) castings used as cast with the metal modified or treated during the melting process, and (3) castings which have to be heat-treated before use. In the first group there are 2L5 (13 per cent. Zn, 3 per cent. Cu); 2L8 (12 per cent. Cu), and 3L11 (8 per cent. Cu), and others of a similar type.

In the second group there are the aluminium-silicon modified alloys. In the third group there are the "Y" alloy, the R.R. alloys and similar alloys.

As the so-called "modified" aluminium-silicon alloys introduced during the last decade have proved to have advantages over the previously-known cast light alloys, for ease in producing sound castings of awkward shape, and are in fact the best alloy for the foundryman to handle, it is proposed to give a brief description of them.

Modified Light Alloys

Composition.—The alloys contain silicon varying from 7 to 13 per cent., and are usually very low in impurities.

Characteristics.—They have physical properties varying from 9 to 13 tons per sq. in. tensile strength with elongation varying from 5 to 18 per cent., and are definitely superior to the older alloys in resistance to corrosion, being especially good for marine service due to their better resistance to salt-water corrosion.

Structure

The refinement of the microstructure which constitutes modification is well known, and it is to the modifying treatment applied that the alloy owes its success. The modifying is carried out by the addition of salts or metallic sodium whilst the alloy is molten. Fig. 6 shows the microstructure of an unmodified 7.5 per cent. Si-Al alloy at 100 diameters, and Fig. 7 shows under similar conditions the microstructure after modification. It should be emphasised that the physical properties of a sand-cast bar represent far more nearly the properties of actual castings than do chill-cast bars which have been so frequently quoted for specification purposes. A bend can be given to the modified 1-in. diameter sand-cast bar similar to a horseshoe, and a normal casting will withstand considerable distortion by hammering before cracking and breaking. The characteristics of this alloy allow box-shaped castings similar to Figs. 8 and 9 to be cast without casing the mould, which is necessary when other light alloys or cast iron are used. It is sometimes found that, for certain services, a cast-iron bearing surface is required, and when this condition arises cast-iron inserts are used. Fig. 10 shows the pattern, mould, cores and cast-iron insert C.I. The runners R in this instance are placed so as to allow the hot metal to enter near the cold insert and assist in obtaining a good bond of the alloy round the cast iron.

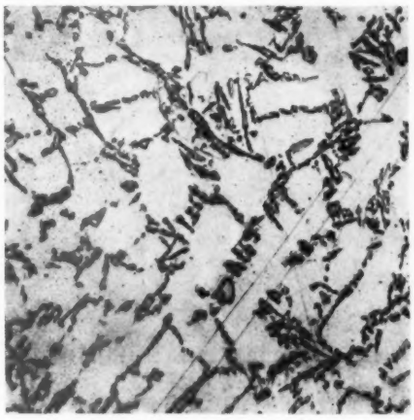

Fig. 6.—Microstructure of Unmodified Al-Si Alloy. × 100.

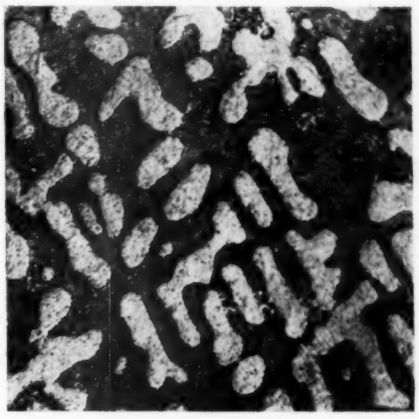

Fig. 7.—Microstructure of Modified Al-Si Alloy. × 100.

Fig. 8.—Frame-Shaped Aluminium-Silicon Alloy Casting.

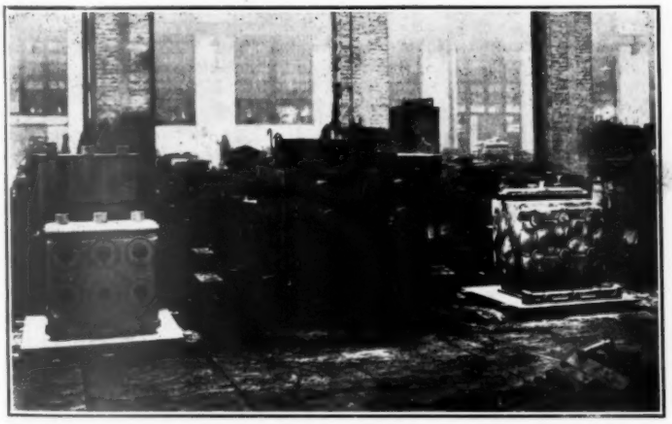

Fig. 9.—Box-Shaped Aluminium-Silicon Alloy Casting.

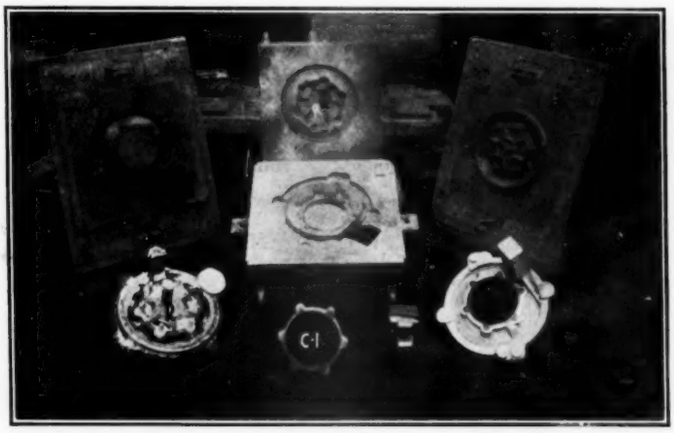

Fig. 10.—Aluminium-Silicon Alloy Casting with Cast-Iron Insert.

Melting

The melting of this alloy is different from that carried out with the brasses and bronzes. In this case, it is advisable to have a slightly reducing flame, as during the slow cooling in the furnace the alloy is able to release the absorbed

gases. If, however, an oxidising flame is used, one is unable to add deoxidisers as in the case of brasses and therefore the alloy is contaminated with detrimental oxides. Fig. 11 shows in the background a battery of open-flame oil-fired furnaces marked O·F used for melting this alloy. In the foreground is a group of miscellaneous castings made in the 7½ per cent. aluminium-silicon alloy.

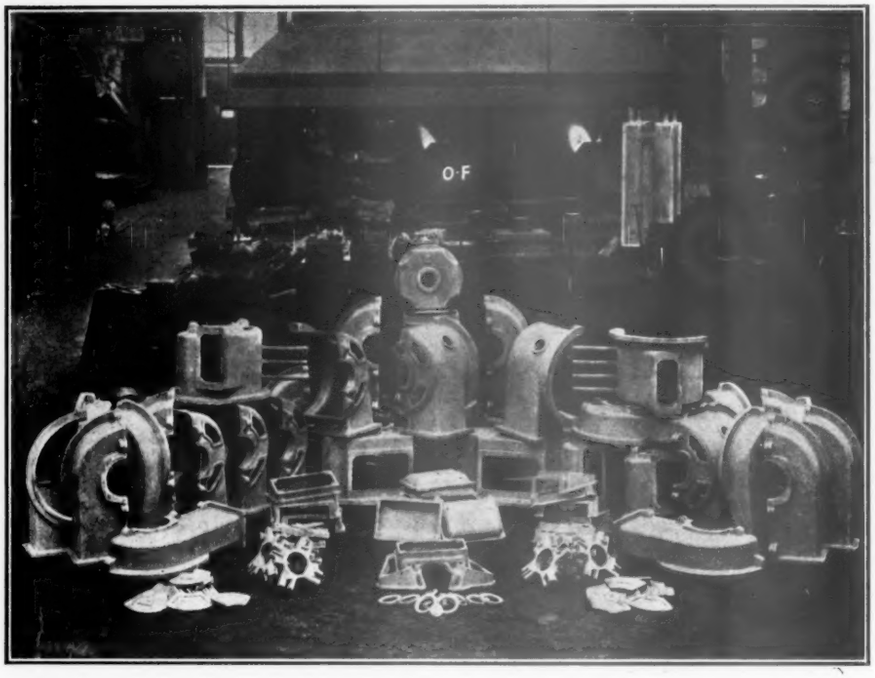

Fig. 11.—Group of Aluminium-Silicon Alloy Castings and (in background) Battery of Oil-Fired Melting Furnaces.

Runners

Aluminium alloys are gated differently from the brasses or copper castings. Aluminium "rolls" somewhat similar to manganese- or aluminium-bronze. This can be seen by observing the rising metal in a feeding head. Any scum or dirt is apt to roll to the outer edges and become trapped, whereas with bronzes and brasses, the metal rises with a slight concave surface, and any scum remains in the centre. Wherever possible aluminium-alloy castings are poured at the bottom, and to do this the use of the horn gate is largely adopted. Feeding heads are in some cases made with straight walls or, if anything, slightly larger at the bottom.

Sand

The moulding sand used is somewhat similar to that employed for ordinary brass castings. If, however, the casting has a large surface area, and the section is small, it is better to use an open coarse red sand freely in the mixture. Locally, the Manchester coarse red as described in a previous Paper* is suitable. Although the face of the casting has a slight bite on it, the metal will be allowed to run freely and give a uniform casting thickness. Fig. 12 shows castings 6 ft. by 21 in., the metal thickness on the plate being ⅛ in. They have been made in sand moulds, and poured in 7½ per cent. silicon-aluminium alloy. Both cores and moulds should be well vented, and the vent wire should be used much more freely than it is used in moulds and cores for cast iron.

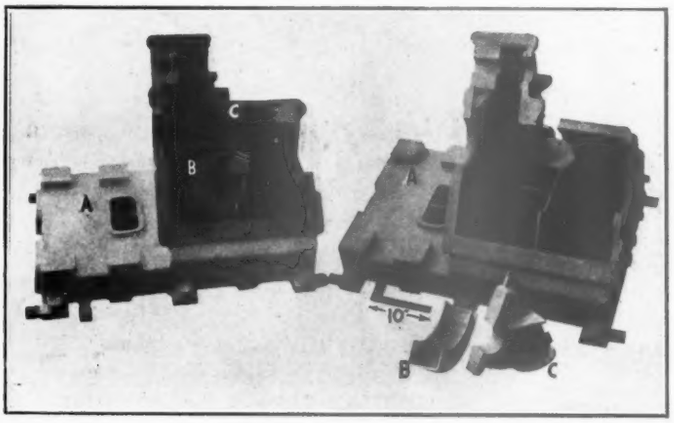

Fig. 13.—Complicated Cast Aluminium-Silicon Alloy Assembly, achieved by Welding together the Three Castings shown on the right.

Welding

Aluminium-silicon alloys can be welded without the usual cracking troubles associated with other aluminium alloys. By using the oxy-acetylene flame with rods of the same composition as the alloy, castings can be satisfactorily welded. Thus, two semi-circular castings when welded together will be free from air leakage when tested with 400 lbs. air pressure and submerged in water. Also, when destroyed by hammering, they will not break at the weld. Owing to the freedom with which this alloy can be satisfactorily welded, the foundryman, when deciding how to make castings, must be "welding conscious." Fig. 13 shows on the right the three simple parts, A, B, and C, which go to make a casting. On the left side are seen these parts welded into position, and these when together produce a job of complicated shape. These castings, when welded together with parts of the welds polished, show the absence of cracks or cavities.

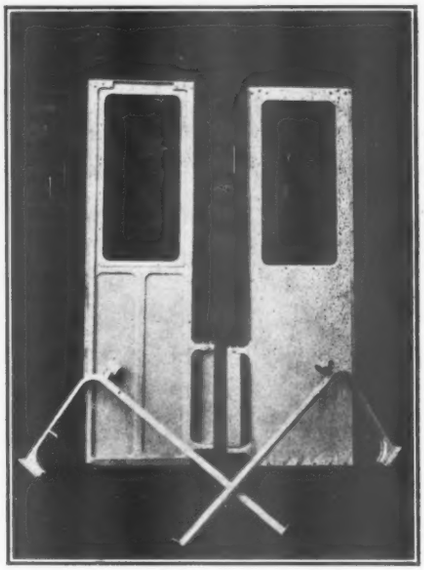

Fig. 12.—Thin Sand-Cast Door Castings in Aluminium-Silicon Alloy.

(*To be concluded.*)

* Foundry Trade Journal, January 30, 1936, p. 102; I.B.F. Proceedings, 1935-36, Vol. XXIX, p. 415.

Book Review

Notes on Cement and Reinforced Concrete. Published by The Ketton Portland Cement Company, Limited, Albion Works, Sheffield. Price 7s. 6d. post free.

First published in 1934, this handbook has been revised to incorporate the principles of the "Code of Practice," and illustrates the basis of contemporary design in reinforced concrete. A design for several commercial structures is given in more detail than is usually found in this type of book, and many practical points are suitably stressed. An unusual feature is the chapter on the design and construction of shuttering, a subject strangely neglected in the standard books on reinforced concrete. Items of general interest are a detailed description of the method of manufacture of Portland cement, and a brief history of the famous Ketton Freestone.

The range covered renders this book a useful addition to the designer's library, but it does not, nor is it intended to, replace the standard books on the subject.

G. L. Faulkner.

The Scottish district committee of the National Union of Foundry Workers has written to the national executive suggesting that the union should make a demand to the Engineering Employers' Federation for an increase of 3d. an hour on the base rate and the restoration of 1931 conditions in view of the rise in the cost of living.

Life of Ingot Moulds

DISCUSSION AT JOINT MEETING IN SHEFFIELD

A joint meeting of the Sheffield Metallurgical Association, the Sheffield Branch of the Institute of British Foundrymen, and members of the Iron and Steel Institute, was held at the Sheffield Metallurgical Association Club, on March 15, to discuss "The First Report of the Ingot Moulds Sub-Committee," forming Section VI of the Seventh Report on the Heterogeneity of Steel Ingots, introduced by Mr. R. H. Myers, Chairman of the Sub-Committee, and presented for discussion by Mr. J. G. Pearce.

In opening the meeting, Prof. J. H. Andrew (Chairman) said that this discussion on the First Report of the Ingot Moulds Sub-Committee had been arranged by the Iron and Steel Institute, and they had the pleasure of having at the meeting not only members of their own society, but members of the Institute of British Foundrymen. On behalf of the Sheffield Metallurgical Association he welcomed the members of the Institute of British Foundrymen to the meeting. The Report, he said, was to be given jointly by Mr. R. H. Myers and Mr. J. G. Pearce, and then Mr. Hinchcliffe would answer the discussion.

Factors Affecting Life

Mr. R. H. Myers (Chairman of the Ingot Moulds Sub-Committee) said that in order to produce results as quickly as possible the Ingot Moulds Sub-Committee had concentrated at the outset on practical aspects rather than on fundamental aspects of the subject. The fundamental aspects were taken care of by Mr. Pearce, Director of the British Cast Iron Research Association, and started with the beginning of the Ingot Moulds Sub-Committee.

As a first step the factors known to affect ingot mould life both during the manufacture and use were set out on the basis of experience, and an attempt was made to determine the relative importance of those factors by (1) practical experiments, and (2) by the examination of individual and collective works data.

Table I.—*Influence of Manganese Content of Mould Iron on Failure by Cracking.*

Mn content of mould iron. Per cent.	No. of moulds.	Percentage cracked.
Over 1.0	11	46
0.90–0.99 ..	96	51
0.80–0.89 ..	243	76
Under 0.8 ..	62	87

Table I showed the effect of varying quantities of manganese and the percentage of cracked moulds, and Table II the effect on mould life of the varying percentages of manganese. That was merely to show what could be done with taking accurate records of mould history.

Table II.—*Influence of Manganese Content of Mould Iron on Mould Life.*

Mn content of mould iron. Per cent.	No. of moulds.	Average life.
Over 1.0	28	89.0
0.90–0.99	139	88.0
0.80–0.89 ..	307	83.2
0.75–0.79 ..	80	77.6

Fig. 1 showed what could be done with the examination of collective works data. There were some 45 examples of all types and sizes of moulds. On the ordinate they had the mould life, and on the abscissa they had the lapse of time between casting and stripping. One would notice the rate of increase or the rate of improvement in mould life. The time was shown in minutes—from 200 minutes in one place, which was substantial, but in another instance it was very great. To the right it would be seen that no advantage was to be had by stripping more quickly—in between the region he illustrated and up to 800 minutes. Those moulds outside the band, which was a fairly narrow band, could be accounted for quite readily.

Fig. 2 was also an example of what could be done with the examination of collective mould data. There they had another 45 examples

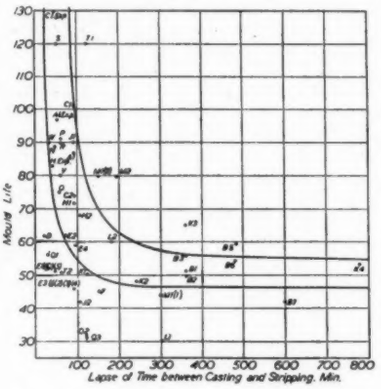

Fig. 1.—Correlation of Mould Life with Lapse of Time between the Casting and Stripping of Ingots.

of all types and sizes of mould. On the bottom was the ratio of minimum wall thickness to ingot weight, from 0.02 up to 0.24; and then they had the mould life. That graph had been somewhat disappointing when it was made out, but on further examination they had found that the points segregated out into spots approximating to the curves he showed.

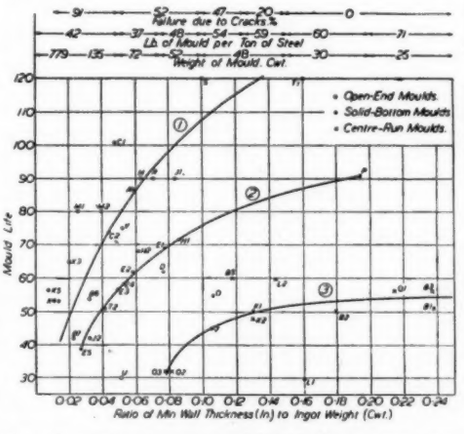
Failure due to Cracks %
Lb. of Mould per Ton of Steel
Weight of Mould, Cwt.
Open-End Moulds.
Solid-Bottom Moulds
Centre-Run Moulds.
Mould Life
Ratio of Min Wall Thickness (In) to Ingot Weight (Cwt.)

Fig. 2.—Correlation of Mould Life with the Ratio of the Minimum Wall Thickness to the Ingot Weight.

No. 1 was for the open-end moulds, No. 2 for the solid-bottom moulds, and No. 3 for the centre-run moulds. On the top they had an average of values vertically of the weight of mould in hundredweights, the pounds of mould per ton of steel, and the failure due to cracks. It would be noticed that the failure due to cracks varied from almost 100 per cent. to nothing with increase in the ratio of minimum wall thickness to ingot weight. Also the pounds of mould per ton of steel, which was the basic economic factor, decreased at first to what might be called an optimum, and then increased to the right. This was of little significance. It almost looked or suggested that moulds to the left of the curve he pointed out were too thin, *i.e.*, the mould walls were too thin. Probably in that case from there onwards the mould walls could be substantially decreased without altering the basic economic factor of pounds of mould per ton of steel.

Cross-Sections Considered

The foregoing, he said, was simply an example of what could be done with accurate data obtained from a number of firms in answer to a questionnaire submitted by the Committee. There was just one more point about one curve in Fig. 2. They had correlated the cross-section of the mould with the cross-section of the ingot on a given plane with mould life, and the result was substantially the same as that shown, only not so clear. It rather pointed to the fact that minimum wall thickness and ingot weight were functions of mould life rather than the cross-section of the mould to the cross-section of the ingot.

It was rather interesting to note those tentative conclusions were confirmed as more data became available. On that occasion he was merely wanting to make an appeal to both mould makers and users alike. If there were mould makers or steelmakers who had not adopted a sound method of recording, he was speaking the mind of the Sub-Committee when he said: "Do by all means adopt a sound method of recording mould history." For instance, in the same type of mould which was made by two mould makers and giving entirely different lives, the question was "Why?" They did not know, because they had not the whole history of that mould during the manufacture. Therefore he urged that all mould makers as well as mould users should adopt a sound method of recording mould history.

He thought there must be a mass of data which had accumulated since the last questionnaire was sent out by the Sub-Committee, and it was desired by the Ingot Moulds Sub-Committee, subject to approval of course of the mould makers and mould users, for Mr. Hinchcliffe, who was the investigator for the Sub-Committee, to be allowed to go round, and see their methods of recording mould data, and also to be allowed to accumulate as much data as possible in order that it might be examined by statistical methods by the Ingot Moulds Sub-Committee.

In conclusion it must be remembered that the massing of data was not only useful to the individual works but to the industry as a whole if the results were submitted for statistical examination by the Ingot Moulds Sub-Committee.

Metallurgical Considerations*

Mr. J. G. Pearce, presenting the Paper for discussion, said that although the life of a mould was judged by the number of heats it withstood before scrapping, or by the pounds of mould per ton of steel, the life of an ingot mould must not be taken as an absolute figure, and the life of one mould, of course, must not be compared with that of another which was perhaps used in different conditions and for different steel. It was not uncommon for the mould maker, knowing the varying results in different steelworks from similar and similarly made moulds, to argue that life differences were due to steelworks treatment, especially as he often had no voice in the important question of design. But while the steelmaker would admit the influence of steelworks conditions, he also knew that moulds from different makers gave different results, as Mr. Myers had mentioned, even when steelworks conditions remained approximately the same for both, and when such experience was available over a period of years it could not be ignored. The Sub-Committee did not aim at locating responsibilities for those difficulties, and on it both users and makers were represented.

* This section has been published in Foundry Trade Journal, Vol. 56, pp. 392-394.

Cost of Moulds in Terms of Steel

The Report tabulated five factors in manufacture and seventeen in use which were considered to govern the life of the mould. With regard to the cost of the mould in relation to the cost of steel, he thought it was worth knowing that if they could save a penny a ton—and they were sometimes asked if they could save a penny a ton on the cost of steel—it meant saving a great deal more than might appear on the surface, because the cost of the mould, if they could take Dr. Swinden's and Mr. Bolsover's figures, was already only 10d. to 1s. 8d. per ton on the cost of steel. So they had to add from 5 to 10 per cent. of the life on to the life of the present mould, and that was quite an appreciable advance.

Influence of Cupola Charge

As Mr. Myers had mentioned, the Sub-Committee worked on three lines—to consider works experiments carried out by members; to examine works records; and to collect and correlate works data. Taking the salient points of the actual works experiments, he asked them to consider the influence of the mixture used in making the mould itself. In the case of some 21-in. semi-closed top moulds, varying the charge material used in the cupola for making the moulds made very little difference to the life. The figures he had all related to batches of moulds and not to single cases. One hundred per cent. hematite in the charge for making the actual ingot mould itself gave a life of 132. The conditions of use, of course, were as near as possible the same in all the cases. Using 100 per cent. scrap (moulds) the life was 127. Using a pig-scrap mixture with 25 per cent. scrap, it was 129; using 10 per cent. scrap with 10 per cent. steel scrap and balance pig, it was 131; 10 per cent. steel scrap by itself with pig gave 133; and a similar mixture with 0.3 per cent. of chromium gave 136, a slight increase, but which did not pay for the cost of the chromium. Thus, speaking very broadly, the actual nature of the charge did not appear to influence the life of the mould. That, of course, was within limits. He would not like to suggest that the founder could use anything he pleased in an ingot mould mixture and get away with it.

Phosphorus Beneficial

With regard to composition, the singular fact emerged that phosphorus was definitely an advantage in the life of a mould. They all knew that hematite iron was used universally, it was imagined, because in the first place the most convenient way of dealing with the used mould was to put it back into the steel furnace. They were heavy and clumsy pieces of metal to deal with, but they were assured to-day that need for disposing of used moulds would not be allowed to interfere with a modified composition. In 1935 a batch of moulds of 0.17 per cent. phosphorus gave an average of 130 lives, but a batch with the normal hematite value of 0.075 per cent. phosphorus only gave 119 in 1936, conditions being the same, of course, for both. Again, a batch of moulds with 0.24 per cent. phosphorus gave 120 lives, but with a normal hematite phosphorus of 0.075 per cent. they gave 115. That just underlined what had been found in certain other directions—that phosphorus did not appear to be disadvantageous within limits. It was not easy to find a reason for that, because phosphide eutectic was not thermal conducting or mechanically beneficial, but it was possible that by reason of its fluidity—its low melting temperature—it filled in gaps which might otherwise exist through shrinkage, and made a continuous metal structure where otherwise there might be a certain number of cavities. A third point was the question of the influence of total carbon. Hematite which was partly converter-blown to give a semi-iron with 2.4 per cent. of carbon—which was much lower, of course, than the usual hematite value—gave a life of nil for four moulds tested, because they all cracked in the first time of use.

Influence of Stripping Time

What was the benefit or otherwise of stripping the moulds earlier than or later than the usual stripping time in the foundry? Eight moulds were stripped in the normal stripping time of ten hours after casting. These were 3½-ton corrugated, wide-end-up, closed-bottom moulds. They gave an average life of 78, which was pretty normal. Eight moulds stripped in five hours instead of ten gave 69, and eight stripped in 24 hours also gave 69. Leaving ingot moulds in the sand over the week-end showed just the same life as those which were normally treated, so that, so far as that test went, there was nothing in taking the moulds out earlier or leaving them in longer than the normal time.

Influence of Annealing

Eighteen moulds were tested, under works conditions—not laboratory tests—and consequently results varied from works to works. The conditions in the steelworks differed, so that the tests were not comparable among themselves, but within the limits of one test the results were so comparable. On an annealing test 18 moulds were tested—used normally—along with six which had been heated before use to 450 deg. C. and kept for ten hours at that temperature, and then allowed to cool slowly in the furnace with the object of relieving stresses. In addition six were annealed at 860 deg. C., which would take them past the pearlite change point, with the object of converting to ferrite. They all failed by cracking, and there was no difference in life between the three batches.

Mr. Myers had already dealt with the important question—possibly the most important point—revealed by the Committee's work so far on the ingot's stripping time. Quicker stripping reduced the temperature reached by the mould, and the mould had a longer time in which to cool. For example, twenty-four 21-in. semi-closed top moulds were stripped in 47 minutes instead of 60 minutes. The life went up from 84 to 92—a matter of 9 per cent. It was not very easy in steelworks practice, of course, to alter the stripping time, but where those experiments were tried, they were very illuminating. When the shop average was 125 lives, ten minutes knocked off the stripping time gave 150 for moulds so treated. Fourteen 3½-ton moulds stripped in 40 minutes as against 90 minutes gave 83 lives as compared with 68 for moulds stripped in 90 minutes. Eight moulds stripped in 45 minutes gave lives of 130 average, as against 94 for a normal 90 minutes. There was one point, however, that could be borne in mind there. Where a set of ingot moulds was allowed to reach maximum temperature in the shop—where the ingot was allowed to stay in that until the mould had reached its maximum possible temperature, then if they doubled the stripping time or trebled it the life was no worse, and of course no better, because by allowing the ingot molten steel to remain in the mould until the mould had reached its ultimate temperature, then all the damage had been done, and no further increase in the stripping time would make any difference.

Influence of Steel Composition

Finally, regarding steel composition, 0.25 per cent. carbon steel gave 145 lives as compared with 128 for steels of 0.40 per cent. or over. In other words, the low carbon steels gave a higher life.

He hoped his statement was clear, as he did not know how far he was justified in assuming that the Report had been read; it had been out a year. Those life figures were averages over a batch of moulds where a test had been made, compared with a batch under other conditions which it was desired to examine.

Going to the data which had been deduced from works records, Mr. Myers had already mentioned the improvement due to the use of 1 per cent. manganese, the best silicon being considered from 1.7 to 1.8 per cent. He thought personally one had to be guarded in concluding from that that a high manganese was necessary. In any ingot mould he believed that the desirable proportion of manganese was related to the proportion of silicon present, and if—as he thought they should—they aimed at a pearlitic structure, then the two elements were obviously related to each other.

Ingot-Mould Casting Temperatures

The results of varying cupola melting temperatures and ladle pouring temperatures were not very definite, but so far they favoured both hot melting and hot pouring.

The third point on the works record deduction was that ageing the moulds prior to use did not increase their life. That apparently agreed with the lack of advantage with regard to annealing—ageing being a kind of long-time, low-temperature anneal through changes in atmospheric temperature.

The fourth point was steel temperature. High steel temperatures were very deleterious indeed to the mould, and moulds used in summer gave shorter lives than those used in winter, and also the longer the interval before successive casts (*i.e.*, the colder the mould to start with) the longer the life.

One of the most interesting features of the Report was that the mould life rose regularly until the point was reached at which the number of lives was nearly double what it was to start with—130 as against something like 70 or 75. Yet at that point a drop took place, and the reason for that puzzled the management for some time, until it was related to the change in temperature, which was found to be the change from summer to winter, summer, winter, and so on. The life in the winter was always higher, because the mould got colder.

To carry on with the deductions from collected and correlated data, the up-hill teeming seemed to give a longer life than direct teeming. Feeder heads reduced mould life, especially when they were embodied in recessed moulds. They simply kept the mould hotter at that point.

Mr. Pearce concluded by considering a few points on the way an ingot mould failed. The failure was either by cracking—and that occurred usually rather early in the life of the mould—or by crazing, which they called minor cracking—the failure in which a network of cracks honeycombed the working face, especially in the middle where the temperature was the highest, with a crocodile marking. This has already been set out in The Foundry Trade Journal.*

DISCUSSION

Following the introductory remarks of Mr. Myers and Mr. Pearce, the meeting was then opened for discussion, and there was an interesting exchange of views in which users and manufacturers of ingot moulds took part. Our report of this discussion will be printed next week.

Catalogue Received

Flue Dust Collectors. Davidson & Company, Limited, of Sirocco Engineering Works, Belfast, in their new catalogue SF66 describe a range of plant they have designed for eliminating the pollution of the atmosphere by flue dust. That they have a wide experience is shown by the fact that more than 1,500 collectors are in use. Most foundry executives are very familiar with magnifications, but we never remember any purely foundry concern which has made any attempt to show to the layman just what magnifications mean. In this publication the thickness of a cigarette paper and a human hair are illustrated at 100 diameters with the object of illustrating what micron dimensions really are. The same intelligent presentation of technical data is apparent throughout the whole of the forty odd pages of this interesting brochure.

* *Loc. cit.*

Transfers for Vitreous Enamelling, and Their Application*

By P. S. MECRATE-BUTCHER

What is a Transfer?

The first material to be considered in the constitution of a transfer is the paper on which it is printed. This must be a high-quality gummed-surfaced transfer paper of a medium weight, to which is applied a patent solito film (one of the few trade secrets); this can be called the colour carrier. The process of printing on this paper is a lithographic one, the printing being carried out on a cylinder machine from stones or zinc plates. A ceramic varnish is used as the printing medium, and the colours are usually automatically dusted on to the medium, after being specially prepared for printing by the ceramic technician. This is known as the dust or dry colour process of printing. A similar effect can be obtained by a wet process, which is the direct printing of a colour mixed with the medium, but this latter process is chiefly used for work requiring pastel or light tints.

One of the principal difficulties to be overcome in the dry process is the staining of the whole sheet by the colour or colours used. All printed sheets are cleaned on a special machine which is known as a dusting-off machine.

The work is applied to the stone or plate in the first case by direct drawing by the artists of the staff, who use a lithographic pen and a special type of greasy ink. As the fundamental principle of lithography is the antipathy of grease and water, it will be understood that only the affected portions of the stone are contacted by the medium used for printing, the rest of the stone being continually kept in a wet state by the damping rollers of the machine. If this were not so, the detail drawing would be lost in a full impression of the stone's surface. The stone on which the work is drawn is known as an original, and is not the stone from which printing is done. Impressions are taken from it and are transferred on to a larger stone suitable for the machine.

In the case of designs which are in more than one colour, a drawing is made of the detail of each colour on a separate original stone, and is printed in register on the machine. This may sound extremely easy, but it is actually one of the major difficulties of the ceramic transfer printer, and depends to a large degree upon the relative humidity conditions in the printing shop, to which reference will be made later.

As each colour is completed, the printed sheets must remain in drying racks for at least twenty-four hours, so that, in the case of a single-colour production, the sheets can be handled for cleaning and cutting, without danger of the work wiping off the sheet. Alternatively, when multi-colours come into the question, unless the sheets are thoroughly dry, the work will transfer from the sheets to the second stone, and fail to pick up the new printing.

The final operations in the process are the cutting of the sheets, sorting, counting, and putting into banded quantities for easy handling and storing. The most interesting of these operations is the sorting, as a very highly skilled inspection staff is necessary, and the most uninteresting (from the operators' point of view) is counting sometimes thousands of transfers, which must each be passed through their hands individually, there being no known method of automatic transfer counting.

Application of Transfers to Enamelled Surfaces

At this stage it will be assumed that the transfers have been supplied to the customer, and he is about to take from store the quantity required for immediate use. Incidentally, it has always been a source of personal amazement that transfers can give satisfactory results when stored under some of the unsatisfactory conditions noted. It is recommended that transfers be stored flat, and in the original bandings, at an even temperature of, say, 60 deg. Fah., well removed from places where there is a tendency to dampness.

Only the quantity of transfers required for the day's work should be taken into the enamelling department, unlike the instance recently experienced during a visit to a firm which was under the impression that the top of the furnace was an ideal storage place. The staff were wondering at the time of the author's visit why the colour and film were deteriorating! If the conditions recommended above are observed, it will be found that the transfers will keep in a perfect state for an almost indefinite period.

Only clean water is satisfactory for fixing the transfer, and to ensure this, it must be changed at regular and frequent intervals. The reasons are that in every enamel shop there is naturally a certain amount of dust, which in time will collect on the surface of the water, and there is also, after a while, a gum deposit in the water from the continual separation of the film from the gummed surface of the backing paper. This, if left in the water, will carry on to the enamel with the transfer, and will prove detrimental in firing.

An essential of a transferring department is organisation or system, which means that facilities should be provided for easy handling, not only of the transfers, but the articles after transferring. This will avoid congestion and the leaving of transfers too long in the water, and perhaps too long after transferring before they are rolled down. The danger of this will be dealt with later on. A brief suggestion for this department is to provide a rigid table or bench for each operative, or if this be impracticable, sufficient space allowed on one bench for each person to have not only his own receptacle for water and transfers, but ample elbow space for the rolling down of the transfer. The benches should be in a good light, and there should be sufficient space around each for the depositing of the articles after transferring, without overcrowding, unless a system is provided for the immediate conveyance of the articles to the drying room. The latter should be as near to the transferring department as may be convenient to the general layout, the object being to avoid, as far as possible, the collection of dust, and also unnecessary carrying of articles fixed with unfired transfers which can very easily be damaged or scratched.

Fixing

The following method of fixing is recommended, but it is open to revision or improvement according to the particular requirements or facilities of the user.

(1) Place the transfer in water at approximately 85 deg. Fah.. and allow it to soak until the film just starts to release itself from the paper.

(2) Remove the transfer from the water, shaking off as much water as possible, lay it on the article, face upwards, slipping one edge of the film over the edge of the paper and drawing the paper from underneath while the film is held fast. It will be found that the film can be readily positioned.

(3) With a soft sponge or cloth smooth out any wrinkles or air bubbles, then place a sheet of blotting paper over the transfer and well roll down with a rubber squeegee roller, being especially careful that no moisture is left between the film and the plate.

(4) The plate is now ready to be put into the drying room in preparation for firing.

(5) The plate should be fired under normal conditions, at a temperature from 750 to 880 deg. C., according to the nature of the work.

Firing of the Transfer

The firing temperature for best results with transfers varies from 750 to 880 deg. C., but is largely dependent upon the type of design, the colours used, and whether the transfers are being fused on enamelled steel ware or cast iron. The latter, carrying enamels melting at a much lower temperature, would not require such a high fire, usually having a longer fire at a temperature of about 750 deg. C. The author is open to correction on these points, as his information has only been secured from personal experience in various enamel shops where he has been called in for investigation or collaboration over transfer productions. Greater care has to be exercised in the selection of design and colours for transfers for cast iron.

A perfect firing of transfers is only possible if the transfer has been properly applied, that is, absolutely flat to the enamel with no trace of water between the film and the enamelled surface. It is fatal to good results to allow the transfer to come into contact with heat until the water is entirely eliminated; otherwise, the film will seal itself to the enamel, enclosing moisture which will cause spitting after firing. So far as it is possible, tests are carried out in the works of the makers to ensure that all transfers produced will give a perfect firing, but users are advised to test a transfer taken at random from the bulk, *before using in bulk*. This will minimise the percentage of scrap, and obviously it is better to be sure than sorry. Perhaps the transfer which will allow of the greatest liberties, both in fixing and in firing, is a transfer printed in black. This colour causes little if any trouble, and the percentage of scrap is almost nil. Colours which cause difficulties, apart from the multi-colour productions which are always treated with greater care, are reds, blues and orange. These colours require very careful control, not only in works production, but for

* Paper read before the Midland and Northern Sections of the Institute of Vitreous Enamellers.

the enameller in his transferring department, and in the fusing. It is as well with these colours to ascertain, from the firing of a small number, the exact temperature and degree of firing which will be most suitable; then, and then only, can the full load be fired with safety.

One of the principal reasons for advising caution is that although the maker may satisfy himself as to the perfection of the transfers, there are other factors which enter into the question, and which are beyond his control, such as an uneven surface of enamel, or an inferior enamel. Of importance also is the quality of the steel or iron, and the variations which can exist even in these. Furthermore, there is the question of fumes in the muffle, which would certainly prove detrimental to *any* transfer. Practical enamellers are in the best position to take care of these problems, and the transfer printer should not be blamed entirely for anything which goes wrong when these essentials are not as correct, or appreciated as they should be.

Co-operation between Designer and Enamelling Department

Co-operation between the designer, the transfer printer and the user is essential. Often a large firm with its own drawing office or staff of designers will prepare a blue-print or coloured drawing which, although artistic, is neither practical for reproduction as a ceramic transfer, nor for firing to enamelled iron. In the past, the author's firm has been asked to manufacture transfers to drawings which have caused endless troubles in production. A principal reason is the difficulty of register, which always exists with ceramic transfer printing, owing to the methods of production, but which is considerably increased when designs are intricate, or wrongly designed. Simplicity in design should be the aim of the artist, but, unfortunately, many designs are prepared with only the artistic effect in view, and with no collaboration with the printer. For example, very fine lettering should be avoided unless the composition of the enamel is such that it will stand a reasonably hard fire. The transfer printer should then be advised of this when the order is placed so that he can select an extra hard colour.

The close contact of two colours should be avoided, as it is a practical impossibility for the printer to ensure that, in every transfer on his printing sheet, these two colours will keep their exact positions. They may overlap, or fail to join, leaving an open space which will show after firing, or thirdly, if joining, may overlap through spreading in the process of fusing.

Apparently designers have a rooted objection to discussing their ideas with the practical staff, and possibly the management does not realise what a fatal mistake it is to lack this essential co-operation between these two departments. If the sharing of ideas and experience could be encouraged it would save the enameller both trouble and expense, and the makers many sleepless nights.

It is worth recording that an order was received, a little while ago, which required transfers to the exact dimensions given on a blue-print. These instructions were faithfully observed, but a complaint was received that the transfer makers had not conformed to the measurements of the drawing. The work was checked over and was found correct, and only when a specimen plate was submitted by the customer was it realised that he had entirely overlooked the fact that the lettering had spread in firing, so that instead of being $\frac{1}{32}$ in. wide it had increased to nearly $\frac{1}{16}$ in.

This is an important point to be remembered, as practically every colour will spread in firing, some colours to only a very small extent, others to almost twice the original thickness. Quite an amount of this spreading may be due to the colour itself, but much depends upon the firing temperature, the length of the fire, and the enamel. Some enamellers object if the colour sinks into the enamel, but they do not stop to think whether they could have avoided this by advising the maker as to their enamel or firing conditions. They could so easily despatch a small piece of enamel for preliminary testing, or themselves make experiments which would illustrate the margin of expansion resulting from their particular enamel and temperatures, and with the various colours.

A further hint with regard to design is to control carefully the question of outlines, particularly where cased lettering is concerned. This, for ordinary printing, is comparatively simple, but for ceramic transfer printing involves certain difficulties, and is best avoided, or more latitude given in the size of the lettering and the thickness of the outline. For instance, the gas combine wordings are a French grey lettering outlined black, or in some cases light blue, or light and medium blue with a black outline, and transfers for these are subjected to an unduly large percentage of wastage in production. Naturally, transfers could not be delivered which were not in perfect register, but a very generous overplus for printing to maintain the standard had to be allowed.

Another point arises with reference to large designs requiring a solid patch of colour, such as red, blue or green. It has been found that transfers over a certain size have a tendency to spit in firing, and show up more readily any slight defect such as a scratch or pinhole. As a substitute, where possible, it is suggested that a shaded or stippled effect be used.

The selection of colours is very important, as the lighter the colour chosen, the more difficult it will be to match this exactly in subsequent printings. For instance, with the French grey referred to previously samples taken from, say, eight different printings of these transfers might disclose three or four very slightly different shades and although every conceivable care was taken it was not possible to overcome this variation. The first difficulty lies with the colour itself, as received from the maker, and no colour-maker will guarantee an exact match, any more than a manufacturer of suitings will guarantee an exact shade of cloth. The next difficulty of matching rests with the transfer maker, in that colour strength depends, firstly, on the weight of medium printed on the sheet, which will pick up more or less colour according to its strength. The control of this depends entirely upon the printer himself, his experience and his method. No two printers work precisely alike, and it is hardly practicable to ensure that the same printer will undertake the repetition work, by which is meant the second, third or fourth order for the same transfer. As the medium is practically colourless, it is not to be expected that the technician can detect a variation in the printing strength. Secondly, where sheets are hand dusted, the strength of colour would depend upon the pressure of the operator. This is another case of the human element, and is the principal reason why it is impossible to guarantee an absolute match. Certainly, in some cases, this would not matter, as for instance where only one transfer is used per article. It would be useless however—as has sometimes been the case—for a customer to fire one transfer and set it up as a standard of colour throughout the firing of all the others, or for future supplies.

Possibly the question of register has been bridged over too quickly, for this is one of the chief problems. Register is controlled by the relative humidity of the atmosphere in the printing shop. A variation of temperature either way means either contraction or expansion of the printing sheet, one equally disastrous as the other. This can happen within half an hour, overnight or during the week-end, and while every possible care is taken in the works to control humidity, there are naturally occasions when these precautions fail.

Limitations of Transfer Production

The largest size of transfer which can be produced is of the order of 29 in. by 39 in. Such a transfer has been printed, but the obvious handicap of so large a size is the transferring of it to the plate. The transfers produced were floated off the backing paper in a flat metal tray which was specially constructed for the purpose. A very large transfer is not recommended by the author, but it is thought that if the design makes it practicable, suitable divisions can be made, and the transfer supplied in two parts or more, which will considerably widen the scope of the ceramic transfer. Naturally, this suggestion could not apply where there were solid patches of colour, but it is quite usual for transfers to be supplied for use in conjunction with stencilling, the latter usually providing the colour of the background, or any other patches of solid colour with which the transfer will not interfere. In the other direction, multi-colour transfers as small as $\frac{1}{4}$ in. square have been supplied, but of course the detail was not excessive.

There are naturally limitations as to colour combinations, and before giving a decisive answer it is necessary to see the design. The difficulties are not so much the printing of the design as in the obtaining of a gam of colours necessary to its reproduction which would be fusible at the same time and temperature.

Colours on Black

Another instance of lack of co-operation, this time between the buying office and the enamelling shop, relates to a case where, instead of a pure gold transfer, the former ordered yellow, and did not realise their false economy until the enamel shop failed to fire them satisfactorily on their black enamel plates. There had to be a tactful reminder that the transfer maker had not been informed that the transfers were to be fired on a black background.

It is unfortunate that there is no ceramic colour, printable by the ordinary process, which is sufficiently highly concentrated or opaque to fire on to a very dark coloured enamel. The only material which can be recommended is pure gold, but for ordinary commercial purposes this is rather too expensive to be practicable. Most transfers are required for firing to a white or cream enamel, in addition to which modern practice has brought in pastel shades of light green, blue, buff, etc. Most colours will fire on to mottled enamels, provided these are not too dark or dismal in colouring.

Acid-Resisting Colours

Another question is whether or not transfers can be produced in acid-resisting colours. This is really a matter for the colour maker, and the transfer makers have not yet been offered colours for enamelled-iron transfers which are specially recommended as acid proof. There may be such colours, but they are unknown, and the only suggestion to be put forward is that, where it is necessary for transfer decorations to be resistant to acid, a clear frit glaze should be applied over the transfers. Enamellers, of course, will know most about this process. The only danger of this is that the glaze may in certain cases tend to dull the colour effect. Transfers in black, however, can be considered practically acid-proof.

In actuality there is only one type of transfer which is suitable in vitreous enamelling, and that is a ceramic transfer, printed in mineral colours to be fused into the enamel. But there *is* a transfer printed in vegetable inks in the positive on single paper, which is floated off in water in an exactly similar manner, fixed to the article, but not fired in. This can only be considered a *temporary* method of badging, because it is not possible to regard it as permanent, in the same way as the ceramic transfer, which actually becomes part of the enamel itself, can be considered permanent.

Moulding Sands and Facings with Reference to Vitreous Enamelling*

By HENRY McNAIR

Good adherence or "grip" is one of the first essentials of a good enamel, but the lack of a satisfactory method for determining the numerical value of adherence is a serious handicap to studies on the subject, and results obtained, and conclusions drawn, have accordingly been treated with caution, and a great deal of suspicion. In a previous Paper† the author examined various mould facing materials, by means of deflection tests on enamelled test-bars, in an attempt to gain some information upon this question of adherence, and the following is a continuation of the study employing a different routine.

After several preliminary trials, it was decided to adopt a test-piece ¼ in. thick and of 1 in. cross-sectional area, *i.e.*, 1.128 in. in diameter. The method of procedure was to prepare and enamel two such test-pieces, and when fusion was complete to lay one test-piece upon the other, enamelled face to enamelled face, and heat for a further 3 mins. to fuse the two test-pieces together. After cooling, the "double" test piece was subjected to tensile strain in the manner shown in Fig. 1. The lower piece was clamped to the base of the machine by means of four screws, and into the top piece, which was drilled and tapped previous to enamelling, a steel hook was screwed, this hook being connected to the source of stress by means of a light steel chain. The testing machine used was one which normally was only suited to transverse pieces. The breaking load was recorded in lbs. per sq. in., and in every test twelve pieces were treated, *i.e.*, six "double" test-pieces were obtained and broken in the above manner, and the maximum, minimum and average results were recorded.

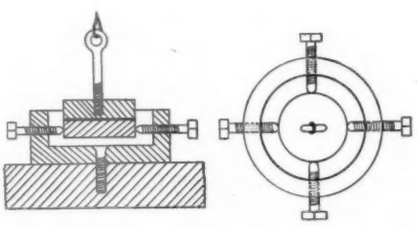

Fig. 1.—Section and Plan of Device for Securing Test-Piece.

In many cases the enamel came away in patches from both top and bottom pieces, this being considered the ideal type of break. For this series of tests, it was decided to use an enamel fired straight on to the metal without a ground coat, one coat only being applied. A gas-fired laboratory muffle was used, the temperature being controlled with the aid of a Cambridge temperature indicator. Where annealing took place this occupied 10 mins. at 850 deg. C., and the fusion of the enamel was carried out at 750 deg. C., the time being 10 mins. with a further 3 mins. after the jointing of the two pieces. All twelve pieces in the set were enamelled at the same time, and only a few hours elapsed between enamelling and testing. It was decided to note, in addition to the tensile load required to part the enamel from the metal, any appearance of gas escape or disturbance during the enamelling, and the appearance of both metal and enamel faces after parting. The sands and facings examined and tabulated in the following were used without any admixture, except in the case of the blended facing sand. The test-pieces cast in these were examined without loss of time, to avoid complications due to oxidation, etc., and the metal analysis varied very little over the series of tests, the average composition being:—T.C., 3.2; Si, 2.8; Mn, 0.5; S, 0.06, and P, 1.0 per cent.

Only three natural sands were examined:—(*a*) A coarse Scottish rotten rock; (*b*) a medium grade Yorkshire sand; (*c*) Erith medium sand, considerably finer than No. 2. A synthetic sand (*d*) was also used, consisting of Southport sea sand bonded with 3 per cent. bentonite. This formed a mould material a little finer than (*b*) but coarser than (*c*). Finally a blended and milled facing sand (*e*) was also tried, consisting of 2 parts floor sand, 1 part Erith medium and 4 per cent. of coal-dust. This would be placed between (*b*) and (*c*) as regards coarseness.

Table I.—*Adherence Values Related to Mould Materials.*

Sand.	Group I. As cast. Tensile. Lb. per sq. in.			Group II. Annealed only. Tensile. Lb. per sq. in.		
	Max.	Min.	Av.	Max.	Min.	Av.
Erith	541	442	416	842	750	805
Rock	302	209	246	291	216	264
Yorkshire ..	569	420	486	344	310	323
Blended facing	382	344	369	418	347	376
Synthetic sand	606	482	534	456	417	440

Preparation of Test-Pieces

Twenty-four test-pieces were cast together, the sand under examination being used in both cope and drag. Twelve pieces were cleaned with a steel-wire brush, and were then enamelled and the "double" test-piece formed in the manner already described. The remaining twelve pieces were annealed, steel-brushed, and enamelled as before.

Values for Adherence

The results obtained from the two groups examined are tabulated in Table I. The six values have been averaged, and the maximum and minimum readings are also shown.

In Group I there appeared to be a considerable evolution of gas at the interface during firing, on all sands. After pulling apart, it was noted that the metal surfaces, where exposed, were very bright and clean, and the corresponding enamel faces were filmed over with a dark coating. This latter coating varied from a dull black in the case of rock sand to a glistening graphite-like film in the case of the synthetic sand, and as far as could be determined visually, the adhesion bore some relation to the nature, *i.e.*, the appearance, of this form on the enamel. The dull black film of the rock-sand pieces gave the lowest adhesion value, and the graphite film of the synthetic sand gave the highest value, the others falling into line between the two. The enamel in all cases was honeycombed and shattered by gas holes, but it was impossible to make any attempt at placing them in the order of bubbling.

In Group II, where the test-pieces were annealed and brushed previous to enamelling, evolution of gas was again noted in all cases, although in the case of Erith this was comparatively slight. After fracture, all the test-pieces again showed a clear, bright metal surface, but in all cases the enamel surface was dull black in colour, with no evidence of the graphitic film found in the unannealed test-pieces. The enamel was honeycombed by gas holes in all cases, the Erith sand being the freer from this defect. The Erith sand showed a very considerable increase in adhesion, with the rock and the blended facing almost similar to the "as-cast" results. The Yorkshire and synthetic sands were much lower than the "as-cast" results, however, and a first impression of this annealed group is that the results show a relationship to the fineness of the metal surface, *i.e.*, to the grade of sand used. The fine Erith sand gave best adhesion and the rock sand the poorest. This relationship was not apparent in the "as-cast" group.

Table II.—*Adherence Values Related to Mould Materials Under Shop-Practice Conditions. (Values in Lb. per Sq. In. Tensile)*

Sand.	As cast. Enamelled at 750 deg. C.	Annealed at 850 deg. C. Enamelled at 750 deg. C.	Group I. Shot-blasted at 60 lb. per sq. in. Enamelled at 750 deg. C.	Group I. Reblasted at 60 lb. per sq. in. Enamelled at 750 deg. C.	Group II. Annealed at 850 deg. C. Shot-blasted at 60 lb. per sq. in. Enamelled at 750 deg. C.	Group II. Reblasted at 60 lb. per sq. in. Enamelled at 750 deg. C.
Erith	416	805	622	731	702	761
Yorkshire	486	323	930	826	752	994
Scottish rock ..	209	264	883	854	657	797
Synthetic sand ..	534	440	482	592	666	824
Blended facing sand	369	376	724	841	802	860

Shop Conditions Reproduced

Table II shows the values obtained from tests carried out under conditions approximating more to those in shop practice. Twenty-four test-pieces were cast as before, from each type of sand, and twelve of these were shot-blasted under 60 lbs. per sq. in. pressure without previous annealing, enamelled, and the double test-piece formed in the usual manner. After pulling apart, the test-pieces were shot-blasted and enamelled and again broken in the tensile machine. The fusion period in the first test thus served as an annealing period for the second test. The remaining twelve pieces were annealed at 850 deg. C., shot-blasted and enamelled as described. After breaking the double test-pieces, each piece was shot-blasted and enamelled a second time, a further series of readings being obtained by what can be regarded as two annealing periods and one fusing. The average values only are given.

Perhaps the most interesting point arising out of the results is that, with the exception of the Scottish rock sand, the highest values are obtained in the last column, *i.e.*, where the test-pieces were subjected to a double annealing,

* Paper presented to the Scottish Section of the Institute of Vitreous Enamellers.

† Proceedings of the Institute of Vitreous Enamellers, Vol. III (1937), pp. 211-225.

or actually a primary annealing and a secondary annealing under a protective cover of enamel, and also to a double shot-blasting. It would, therefore, seem that either the extra annealing or the extra shot-blasting has raised the adhesive value of the test-pieces.

Comparing Columns 3 and 4, the extra shot-blasting has considerably increased the values in three of the sands, the rock sand test-piece has dropped slightly, and the remaining sand has suffered a fair decrease, although the final value still remains high. On the other hand, Column 5 shows that annealing, before shot-blasting, has not brought the values up to those obtained by the additional shot-blasting, except in the case of synthetic sand, *i.e.*, the lowest in the group. Additional shot-blasting would therefore appear to be of more benefit than additional annealing, and Column 6 appears to bear this out.

Table III.—*Influence of Facing Materials on Enamel Adhesion.* (*Values in Lb. per Sq. In. Tensile.*)

Facing material.	Group I.		Group II.	
	Shot-blasted at 60 lb. per sq. in. Enamelled 750 deg. C.	Reblasted at 60 lb. per sq. in. Enamelled 750 deg. C.	Annealed 850 deg. C. Shot-blasted at 60 lb. per sq. in. Enamelled 750 deg. C.	Reblasted at 60 lb. per sq. in. Enamelled 750 deg. C.
Plumbago	654	802	498	792
Lamp black ..	532	693	627	615
Wood black ..	561	690	624	769
Patent black ..	666	751	632	733
Coal-dust	580	618	666	669

The average values from Table I have been included in Table II, and are shown in Columns 1 and 2. Comparing these with Column 3, further evidence appears that shot-blasting increases adhesion and, with the one exception, annealing lowers the value. The values in Column 3 show that shot-blasting without annealing compares favourably with any subsequent treatment with the exception of the synthetic sand. In this column no bubbling or pinholing was observed, and the enamel was sound at the interface. It is also worthy of note that, in the as-cast test-pieces, considerable evolution of gas had taken place at the interface. This persisted in the annealed test-pieces, but disappeared where the pieces were shot-blasted, *i.e.*, in Column 3. In addition to increasing adhesion, therefore, it would appear that shot-blasting tends to eliminate bubbling and pinholing; or, perhaps, it would be more apt to conclude that the elimination of the interfacial reaction has resulted in a sounder enamel base and therefore a higher adhesive value.

PART II.—INFLUENCE OF MOULD FACINGS

The series of carbonaceous facing materials examined included plumbago, lamp black, wood blacking, patent blacking and coal-dust, and these were dusted on to the mould surface of cope and drag. The mould material used in all cases was floor sand, and the test-pieces were cast, prepared and examined as previously described. The values for adhesion are set out in Table III, the average results only being given.

No tests were made upon the as-cast pieces or after annealing only, but the above results corroborate, in some measure, the results obtained during the examination of the sands. Comparing Columns 1 and 2, it is evident that re-blasting of the test-pieces has definitely improved adhesion in all facings. Column 3 shows that annealing before shot-blasting has not the same marked effect, actually lowering adhesion in the case of plumbago and raising it in only one case, *i.e.*, coal-dust. It is worthy of note that these two facing materials are at opposite ends of the range with reference to volatile content, and that, after annealing the plumbago test-pieces, the graphite on the metal surface seemed very little affected and glistened almost as brightly as in the as-cast state. This was not noticeable with any of the other facing materials. The results in Column 4 show no marked improvement over those in Column 2, and those in Column 3 have little advantage to show for the additional annealing given them as compared with the values in Column 1.

Table IV shows the proximate analysis of the carbonaceous facing materials used, but it is difficult to correlate the test values obtained with any one constituent in these analyses. If Columns 2 and 4 are taken as giving the best results in Table III, then it is possible to correlate the values to certain factors. Column 2, where shot-blasting is the principal treatment, places the facings in the following order according to their adhesive values:—

(1) Plumbago.
(2) Patent blacking.
(3) Lamp blacking } Similar.
(4) Wood blacking }
(5) Coal-dust.

This order is similar to that of the volatile content of the facings, ranging from low-volatile content plumbago to high-volatile coal-dust.

Table IV.—*Analyses of Carbonaceous Facings.*

	Coal-dust.	Lamp black.	Wood black.	Pat. black.	Plumbago.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Moisture	3.34	5.77	6.94	1.51	1.01
Volatile	35.21	18.81	12.00	3.98	0.73
Ash	10.09	27.15	9.83	22.85	10.84
Fixed carbon ..	51.36	48.27	71.23	71.66	87.42

According to Column 4, however, where a longer annealing has been given, the order is changed to:—

(1) Plumbago.
(2) Wood blacking } Similar.
(3) Patent blacking }
(4) Coal-dust.
(5) Lamp blacking.

The only other factor in the analysis coinciding with the above is the fixed carbon content, and again plumbago is at one end of the list, with lamp blacking at the other.

In a previous Paper* by the author, where bend tests were carried out on Keep's bars, it was said, in summarising, that "it may be more than singular that coal-dust, with the highest volatile content, should give best results, and that plumbago and patent blacking should be relatively bad." The results of the present tensile tests suggest a complete reversal of these views, as plumbago and patent blacking must be regarded as giving superior adhesion in comparison with coal-dust. It is possible, however, in the bend tests, where the enamel cracked extensively before breaking away, that this should have been regarded as a sign of a much closer grip or fusion to the metal base than in the cases where little or no cracking occurred before breaking away. In the latter case, a certain amount of interfacial slip may have occurred between metal and enamel before the bend on the bar caused the final fracture. If this explanation of the bend test holds, then the results of the present series corroborate to a great extent the conclusions previously arrived at.

Conclusions

The most interesting outcome of the test is undoubtedly in connection with annealing and shot-blasting. Whatever other benefits may be derived from annealing, it would appear evident that it in no way enhances the adhesion of the enamel to the metal. On the other hand, shot-blasting shows a marked improvement in this connection, and a closer study of this branch of the process may be of great value to the industry. So far as a comparison of the sands can be attempted, the only definite relationship between these and the values of adherence would appear to be in the fineness of the material. The finer sands gave very good values, but the coarser sands were much lower, but as no analyses and grading tests have yet been made, little more can definitely be stated at present.

Table V.—*Comparative Methods of Cleaning, Etc.*

	Stoning.	Filing.	Pickling (HCl, 50 per cent.)	Shot-blasting.	Rusted in atmosphere 14 days.	Fe_2O_3 treatment.
Cleaned; enamelled, 750 deg. C.	394	355	356	622	—	—
Recleaned; re-enamelled, 750 deg. C. ..	414	338	—	731	—	—
Annealed, 850 deg. C.; cleaned; enamelled, 750 deg. C.	423	456	360	702	—	—
Recleaned; re-enamelled, 750 deg. C. ..	464	411	—	761	—	—
Shot-blasted, 60 lb. per sq. in.; enamelled 750 deg. C.	—	—	—	—	165	—
Annealed, 850 deg. C.; shot-blasted, 60 lb. per sq. in.; enamelled, 750 deg. C. ..	—	—	—	—	768	740
Annealed, 850 deg. C.; shot-blasted, 60 lb. per sq. in.; coated with Fe_2O_3; enamelled, 750 deg. C.	—	—	—	—	—	743

PART III.—INFLUENCE OF CLEANING METHODS

It was decided to examine and compare the results of test-pieces which had been cleaned or prepared by different methods. To this end, pieces were cast as before, and the same routine employed. Table V shows the results obtained by four methods of cleaning, the test-pieces having been cast in Erith sand. It will be noted that there is comparatively little difference between those prepared by stoning (with a Carborundum stone), filing, and pickling in HCl 50 per cent. (15 mins. at 15 deg. C.). The shot-blasting shows values much superior to the others, and certainly gives what would appear to be a better surface, if the grip is to be more mechanical than chemical.

Also shown in Table V are the results obtained on test-pieces allowed to lie in the open for 14 days, and then treated. Twelve were shot-blasted and enamelled, and the remainder annealed, shot-blasted, and enamelled.

(*Concluded on page* 300.)

* *Loc. cit.*

A. England, M.Sc. (Mch.)

W. E. McCalla

B. A. McCalla

W. Ball

N. Bowen

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Enamelling News

Scottish vitreous enamellers are again to be hosts to members of the Institute at Whitsuntide. Social functions will include tours of the Empire Exhibition and an excursion on Whit Sunday to Killiecrankie. A technical session and works visits are also being arranged. Early application for participation is essential.

* * *

The annual conference is to be held in London this year, and the Hotel Normandie in Knightsbridge has been selected as headquarters. Make a note of the dates—October 28 to 30.

* * *

At a meeting of the Southern Section, held last Thursday, Mr. W. Thomas, of Metters, Limited, was elected Chairman in the place of Mr. V. C. Faulkner. The position of honorary secretary, previously held by Mr. Thomas, is to be filled by Mr. Alastair McLeod, Editor of "Sheet Metal Industries."

* * *

An extraordinary meeting of the Midlands Section is to be called for the purpose of listening to a special selection of American technical Papers.

* * *

Mr. J. H. Coupe has now transferred his activities from vitreous enamelling to refractory brickmaking in South Wales. He has the best wishes of all enamellers in his new enterprise.

* * *

Mr. H. Cowan, B.Sc., has joined the staff of Flavel & Company, of Leamington. For many years he has acted as superintendent of the Scottish Laboratories of the British Cast Iron Research Association at Falkirk.

* * *

Mr. Charles S. Pearce has been appointed secretary of the Porcelain Enamel Institute, Mr. George P. MacKnight having resigned. The office is situated at 612, N. Michigan Avenue, Chicago, Illinois, U.S.A.

* * *

A complete block of shops has recently been erected in Detroit, Michigan, of the type one sees in Britain at the sides of railway approaches. The fronts of these single-storey shops have been carried out in coloured vitreous enamel.

* * *

Last year the American building industry consumed £1,000,000 worth of vitreous enamelled sheets, whilst the United Kingdom architects entirely neglected the idea.

* * *

Members of the Institute have now received a circular letter detailing a preliminary itinerary for the visit to the U.S.A. in October. It is proposed to use aeroplanes for transport in order to eliminate tiresome night railroad journeys and to enable the visitors to spend a maximum amount of time in the numerous shops which are to be opened for inspection.

* * *

The Parkinson Stove Company at Stechford has gone a long way towards the solution of the automatic enamelling problem, whilst real headway has been made in fuel conservation of the fusing furnaces by automatic loading.

* * *

De-enamelling by a patented process is now being undertaken by the Sterling Manufacturing Company, of Cubitt Town. It is claimed that enamel can be removed from sheet without distortion in sixteen seconds.

* * *

The following table of exports of enamelled ware from Germany is interesting in two respects. It shows that the United Kingdom is normally a good customer for German vitreous enamelled ware, and that Venezuela is now taking large quantities. This country is figureing largely in other fields of export and is worth examination by business men.

Export of Enamelware from Germany, in Metric Tons.

Country.	1935.	1936.	1937.
United Kingdom ..	1,097	923	1,232
Columbia	1,022	1,279	551
Gold Coast ..	874	1,585	1,091
Nigeria			951
France	629	317	262
Holland	549	657	680
Peru	408	659	463
Argentine	366	229	190
Cuba	346	221	364
British South Africa	281	262	244
British North America	270	332	332
Venezuela	266	838	1,778
Denmark	174	231	298
Siam	138	124	178
Belgium	73	62	81
French West Africa	77	166	218

Moulding Sands and Facings with Reference to Vitreous Enamelling

(*Concluded from page* 298.)

The great improvement in the values from the latter method emphasises the importance of annealing, where rusting has occurred to any great extent.

The last column shows values obtained on test-pieces treated similarly, but one group being coated over with dry Fe_2O_3, previous to enamelling. The coating was fairly liberal, but appears to have made no difference to the adhesion, whatever other effect it may have had upon the physical properties of the enamel.

Works Management Association

Though most of our readers know of the Works Management Association because of an annual cricket match with the Institute of British Foundrymen, they are not too cognisant of its major activities. No excuse, however, can exist in the future, as the Association has now prepared a ten-page booklet which outlines its activities, governing bodies and its training and examination schemes. It is available to our readers by writing to the secretary at Terminal House, 52, Grosvenor Gardens, London, S.W.1.

The training and examination scheme is of particular interest, and courses are now being prepared in a number of technical colleges in the principal industrial centres. When time has elapsed for candidates to complete the prescribed courses, entrance by examination will be the basis of membership. For a limited time, however, senior works managers will be eligible without examination. The scheme is the result of the work of the Professional Standards Committee, which has been taking evidence and pursuing researches for three years.

Paid Holidays for Steelworks' Engineers

The Amalgamated Engineering Union has concluded a holidays with pay agreement with the Iron and Steel Trades Employers' Association, the Cleveland Ironmasters' Association, the West Coast Ironmasters' Association, and the Lincolnshire Ironmasters' Association. The agreement covers A.E.U. members employed by firms in these associations, who are mostly maintenance men. It is on similar lines to that made with the Engineering Employers' Federation giving six days holidays with pay.

Company Meetings

British Aluminium Company, Limited

The annual meeting of the British Aluminium Company, Limited, was held in London last week. Mr. R. W. Cooper (chairman), who presided, said that the profit for 1937 amounted to £773,432, which was an increase of £176,252 over the profit realised in 1936. They commenced the year with a satisfactory order-book, and the demand for their products was well maintained throughout the year, resulting in their marketing a considerably increased tonnage of aluminium; in fact, the largest in the history of the company. The home and the export sales both contributed to this increase, which was distributed between ingot metal and rolling-mill products. The price of the former, and to a great extent the latter, remained steady. On the other hand, costs of production were higher, due to the rise in cost of raw materials and to increased labour rates. These latter were further increased at the beginning of the current year, and, in addition, the system hitherto in operation by which men employed on necessarily continuous processes worked seven shifts of 8 hrs. each per week, had been replaced by a system of six shifts of 8 hrs. per week, without any reduction in average weekly earnings. The effect of this change, and of the increases in labour rates and other improved conditions introduced during the last one and a-half years, represented an addition of 20 per cent. to their wages bill in this country, apart from the additional cost of the larger number of men who were required to operate their various extensions of plant. At the commencement of 1937 all the factories of the company were working at full capacity, but during the year there was some interference with the output of aluminium due to circumstances beyond their control. In September they were involved in a strike affecting the whole electrochemical industry in Norway, which resulted in the cessation of aluminium production in that country for a month. At Kinlochleven they had an unprecedented experience as regards the incidence of the rainfall towards the end of the year. The first half of the additional aluminium producing plant at Lochaber was put into commission early in March. At Lochaber they possessed by far the largest hydro-electric development in Great Britain. The enlargement of the alumina works right up to the boundary of their property at Burntisland was nearing completion, and as the extra amount of alumina thus provided would be insufficient for their requirements, they had to find another site for a new, and a third, alumina factory. They finally decided that the most suitable location was at Newport, Monmouthshire. This factory they hoped would reach the producing stage later on this year.

W. Canning & Company, Limited

Mr. Ernest R. Canning, presiding at the annual meeting of W. Canning & Company, Limited, said that they had been working at high pressure, but, nevertheless, had borne in mind the necessity for continuing their efforts to keep abreast in the development of new processes in electro-plating and of new methods in automatic polishing. There had been considerable development in bright nickel plating, but there had been many teething troubles. They were now able to offer a process that compared favourably with any in the world. They had also successfully introduced bright zinc plating, which gave a pleasing finish and had been welcomed as a substitute for cadmium since the latter metal had increased so much in price.

Gibbons (Dudley), Limited

Presiding at the annual meeting of Gibbons (Dudley), Limited, in Birmingham, last week, Mr. C. S. Bennett said the firm had suffered severely from the shortage of supplies and protracted deliveries. The output of fabricated steel was 500 tons less than in the previous year. They might suffer from the shortage this year owing to the priority given to armament work. For these reasons the directors thought they were justified in placing a further sum of £2,500 to the dividend equalisation fund, and adding a sum of £4,000 towards the modernisation of plant.

Craven Bros. (Manchester), Limited

At the annual meeting on March 30 of Craven Bros. (Manchester), Limited, Mr. J. R. Greenwood (chairman and managing director) said that the output for the year was considerably in excess of all previous records. The value of orders on their books on December 31 last was almost double the value of orders on December 31, 1936. Their order-book at the moment was such that they were assured of a continuity of work to keep them well employed for a period of at least 2½ years ahead.

For general improvement of Cupola Mixtures

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A NEW MEDIUM PHOSPHORUS FOUNDRY PIG IRON

Total Carbon	**3.5 - 3.7%**
Silicon	**2 - 2½, 2½ - 3, 3 - 3½%**
Sulphur	**0.05%**
Phosphorus	**0.5 - 0.75%**
Manganese	**0.7 - 1.0%**

Of similar characteristics to Scotch irons, Glenton is recommended for the production of general engineering castings of high strength but low cost.

The Stanton Company have many years' experience of metallurgical problems. This experience is at your disposal on any problem in connection with the Foundry.

THE STANTON IRONWORKS COMPANY LIMITED
Near NOTTINGHAM

The Largest Producers of Foundry Pig Iron (for Sale) in Great Britain

The Week's News in Brief

Trade Talk

Harland & Wolff, Limited, have received orders from the Blue Star Line for two express refrigerated cargo motorships.

The Consett Iron Company, Limited, achieved a new record for the output of the steel furnaces—8,300 tons—in a week. For more than 20 years the record weekly output of steel from eight furnaces had stood at 8,014 tons.

Oesterreichische Alpine Montangesellschaft, Vienna, is to resume dividend payments on its share capital of 60,000,000 schilling, with a distribution of 4 per cent. for 1937. The last dividend, also of 4 per cent., was paid on account of 1929.

The Ideal Home Exhibition at Olympia, London, was opened on Tuesday. Several well-known stove, grate and range foundries are exhibiting in the heating and lighting section, as well as gas-stove and radiator manufacturers. The Exhibition closes on April 30.

All home representatives and several Continental representatives of Head, Wrightson & Company, Limited, Thornaby-on-Tees, were in attendance at a sales conference, held at the head office and works recently. An organised tour of the works, covering iron and steel foundries, laboratories, bridge and constructional yard, drop forgings and stampings department and machine shops, was made, and in the steel foundry department the representatives witnessed the casting of a 8½-ton molybdenum hammer guide.

The lull in employment in the iron-fitting industry is referred to by Mr. James Fraser, general secretary of the Scottish General Iron Fitters' Association, in his annual report for 1937. As many as a thousand, he states, were weekly signing the idle book in Falkirk during the last three months. The Association, however, had high hopes of a long spell of good work, and they calculated that a million new houses were required in Britain. If so, that meant a considerable amount of work for their industry. The Association feared, however, that the placing of orders would come in an unnatural rush, and all their men would be absorbed, to the probable extent of overtime.

The Governors of the British Foundry School at Birmingham announce that the fourth session of the School will open on September 20, 1938. The present session will conclude at the end of July. The course is for one academic year, and is intended for men of some practical experience and technical training, preparing for higher responsibilities in the foundry industry, and includes cast iron, malleable cast iron, steel and non-ferrous metals. Further information and forms of application may be obtained from the Secretary of the School at the Central Technical College, Birmingham, or from the Honorary Treasurer and Adviser, 21, St. Paul's Square, Birmingham, 3.

The Bureau of Analysed Samples, 3, Wilson Street, Middlesbrough, announces that two new standard steels are ready for issue. Free-cutting carbon steel "D," which contains C 0.114, Si 0.007, S 0.237, P 0.082, and Mn 0.810 per cent., is a typical high sulphur and phosphorus free-cutting steel, and is of particular interest in connection with the determination of the high sulphur content and the low carbon, by combustion, in the presence of high sulphur. Steel "F," with C 0.525, Si 0.109, S 0.032, P 0.050, and Mn 1.010 per cent., is a typical 0.5 per cent. basic open-hearth carbon steel, but with phosphorus and manganese near to the top limit which is frequently specified. As usual, each standard has been analysed by a number of chemists experienced in the analysis of that particular class of steel. The standards are issued in bottles containing 25 grms., 50 grms., 100 grms., and 500 grms., each bottle being provided with a certificate showing the analysis of each chemist, together with a reference to any feature of interest in connection with the determination of each element. The standards may be obtained direct from the Bureau, or through any of the usual chemical dealers.

The holiday arrangements of most of the big Sheffield steelworks have been announced. The English Steel Corporation, Limited, will shut down on Friday night, July 22, and will reopen on Tuesday, August 2. Similar arrangements will be in operation at the works of Industrial Steels, Limited, Thomas Firth & John Brown, Limited, and Firth-Vickers Stainless Steels, Limited. Edgar Allen & Company, Limited, will close down during August Bank Holiday week. At the works of the United Steel Companies, Limited, where it is not possible to close down a department, holidays will be spread over a period. In departments which can be closed down all the men will take their holidays together. Employees of Samuel Osborn & Company, Limited, will be taking holidays in August Bank Holiday week. The Sheffield Forge and Rolling Mills will close down during the first week in July. Workmen employed by Davy & United Engineering Company, Limited, have been given the opportunity of taking their holiday in the period of the last three weeks in July and the first three weeks in August. Brown Bayley's Steel Works, Limited, will close down either during the last week in July or the first week in August. At Hadfields, Limited, it had been decided to close down, but the holiday week has not yet been chosen. For the first time, in most instances, the men receive holidays with pay.

Personal

Mr. George Blair, of Shanks & Company, Limited, Barrhead, has retired after 28 years' service.

Mr. George Mason, who has held the position of works foreman at the Codnor Park works of the Butterley Company, Limited, for 26 years, has retired.

Mr. Eric Sellman, of Sellman & Hill, Limited, hollow-ware makers, of Wolverhampton, has been elected chairman of the Wolverhampton Chamber of Commerce.

Dr. H. W. Gillett, chief technical advisor to the Battelle Memorial Institute, Columbus, Ohio, is to deliver the 1939 Howe Memorial Lecture of the American Institute of Mining and Metallurgical Engineers.

Mr. William Geary, melting shop manager at the works of Dorman, Long & Company, Limited, Middlesbrough, is to be presented with the Williams prize for 1937, at the annual meeting of the Iron and Steel Institute, to be held in London in May. This prize was presented by the late Mr. Illtyd Williams when he resigned his position as the hon. treasurer of the Iron and Steel Institute, with the object of encouraging the writing of Papers of technical and practical interest by young members of the staffs of iron and steel manufacturers. Mr. Geary's Paper was on hot metal practice in five melting shops in the North-East Coast area.

Obituary

The death occurred last week of Mr. A. C. Briscoe, managing director of W. H. Briscoe & Company, Limited, brassfounders and stampers, of Tyseley, Birmingham.

Mr. L. D. Whitehead, chairman of the Whitehead Iron & Steel Company, Limited, died suddenly on March 27. Born in 1877 at York, he joined the Tredegar Company in 1899 as assistant works manager, and when that company declared its intention to abandon its steelworks bought the lease and in 1906 formed the Whitehead Iron & Steel Company. Works were built at Newport in 1920, and they became recognised as one of the most efficient rolling mill units in the world. Mr. Whitehead about 15 years ago introduced a co-operative system of paying all employees the same dividend on their wages as that paid to shareholders. He was High Sheriff of Monmouthshire in 1927, and was a staunch supporter of the Wales and Monmouthshire Development Council.

A New Metro-Vick Calendar

We acknowledge with thanks the receipt from Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, of a copy of their "Girl" Calendar for 1938. The subject this year is the winner of the recent "Miss England" Beauty Competition.

Company Reports

Lancashire Steel Corporation, Limited.—Half-yearly dividend on the 5 per cent. cumulative first preference shares.

North British Aluminium Company, Limited.—Trading profit for 1937, £181,152; loan interest, £99,747; tax, £13,193; depreciation, £7,500; brought in, £21,849; to reserve, £30,000; carried forward, £52,561.

Engineers & Ironfounders, Limited.—Net profit for 1937, £4,744; brought in, £8,264; preference dividends, £1,805; final ordinary dividend of 7½ per cent., making 10 per cent., plus a bonus of 6d. a share; carried forward, £8,436.

G. D. Peters & Company, Limited.—Net profit for 1937, £38,295; written off reorganisation expenses, £329; debentures redemption reserve, £30,000; dividend at the rate of 15 per cent. per annum in respect of the five months ended December 31 last; carried forward, £4,392.

Contracts Open

Dewsbury, April 23.—Cast-iron pipes, for the Town Council. Mr. G. E. V. Boldry, water engineer, 10, Church Street, Dewsbury.

Dublin, April 26.—Supply and erection of 4-ton level luffing electric portal wharf crane, for the Port and Docks Board. The Engineer, East Wall, Dublin. (Fee £1, returnable.)

Singapore, April 25.—Two electrically-driven centrifugal-type pumping sets, for the Municipal Water Department. The Department of Overseas Trade. (Reference T.Y. 19,789/38.)

Wellington, June 13.—Railway workshop machinery, for the New Zealand Government Railways Administration. The Department of Overseas Trade. (Reference T. 20,008/38.)

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 117, Chancery Lane, London, W.C.2.)

Griffiths & Jukes, Limited, Rolfe Street, Smethwick.—Capital £1,000. Iron and brass founders, etc. Directors: A. E. Griffiths and S. E. Jukes.

North Eastern Marine Engineering Company (1938), Limited.—Capital £1,000. Subscribers: H. M. Stobart, Middlethorpe Hall, York; and R. S. Middleton.

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

478,916. Heraeus, Ges., W. C. Production of metallic surface layers.

479,051. Wellman Seaver Rolling Mill Company, Limited, and McLay, G. S. Apparatus for the manufacture of metal tubes and other tubular articles.

478,951. Neunkircher Eisenwerke Akt.-Ges. vorm. Geb. Stumm, and Haag, J. Production of iron and steel.

478,978. Reicherter, G. Hardness-testing machines.

Forthcoming Events

APRIL 12.

Institute of Marine Engineers:—"The Acid-Bessemer Process," Paper by Dr. T. P. Colclough, at 85, The Minories, London, E.C.3, at 6 p.m.

Institution of Mechanical Engineers (South Wales Branch):—"Breakdown in Prime Movers," Paper by Eng. Lt.-Commr. C. T. Phillips, at Royal Metal Exchange, Swansea, at 6 p.m.

APRIL 14.

Institute of Metals (Birmingham Section):—Chairman's address, by W. F. Brazener; annual general meeting, at James Watt Memorial Institute, Birmingham, at 7 p.m.

STEEL FOUNDERS!

For **"easy Stripping"** use

YORKSHIRE SAND

Yorkshire Sand is of a synthetic nature, its production being under careful laboratory control. Perfect standardization is obtained with the various grades, suitable for light and the heaviest steel castings.

It is because of the refractoriness of the sand and of the toughness of the mould surface that castings made with Yorkshire Sand are distinguishable by their excellent finish.

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LONDON OFFICE: Russell House, Adam St., Strand, W.C.2. Telephone: Temple Bar 3511. Telegrams: "Genefax, Rand-London." (Mr. A. C. Turner).

SCOTTISH OFFICE: 48, West Regent Street, Glasgow, C.2. Telephone: Douglas 6108. Telegrams: (3 lines). "Genefax, Glasgow."

SWANSEA OFFICE: Metropole Chambers, Wind Street, Telephone: 3680. Telegrams: "Genefax, Swansea." (Mr. D. F. Hood-Williams).

MANCHESTER OFFICE: 9, Albert Square. Telephone: Blackfriars 6130 Telegrams: "Genefax, Manchester." (Mr. S. G. Throssell).

MIDDLESBROUGH OFFICE: Halifax Bldgs., Exchange Place, Telephone: Middlebrough 3313. Telegrams: "Genefax, Middlebrough." (Mr. J. A. Williams).

CARDIFF OFFICE: 17, Windsor Place, Telephone: 5796. Telegrams: "Genefax, Cardiff." (Mr. F. E. Rutter).

Raw Material Markets

The Import Duties Advisory Committee have still to make known their decision with regard to the restoration of the import duty on pig-iron. Meanwhile, new business is negligible, and both makers' and consumers' stocks are heavy. Producers of Cleveland foundry iron have temporarily suspended regular production.

Pig-Iron

MIDDLESBROUGH.—In view of the large stocks which consumers now have on hand, it will be a considerable time before buying is resumed on a normal scale. Makers' stocks will no doubt be adequate to meet supplementary demands, and the decision of the producers to suspend regular production of Cleveland iron will occasion little surprise. For deliveries in the Middlesbrough or Falkirk areas, No. 3 Cleveland G.M.B. foundry iron is quoted at 109s. per ton, No 1 foundry at 111s. 6d., and No. 4 foundry and No. 4 forge at 108s., all less 5s. rebate.

Consumers of hematite are well covered ahead and are not inclined to enter into further contracts. Consumption is maintained at a satisfactory level. Steelmakers, especially, are taking up heavy tonnages. East Coast mixed numbers are quoted at 132s. 6d. on the North-East Coast, 138s. in Sheffield, and 143s. 6d. in the Midlands, all less 5s. per ton rebate.

LANCASHIRE.—Quiet conditions continue to prevail in this area. New business is restricted to small tonnages for early delivery, despite the fact that makers would accept orders for third-quarter delivery. Operations at many of the consuming plants are still below the average level for the time of the year and it cannot be said that the outlook is at all satisfactory. Machine-tool makers and heavy electrical engineers are exceptions to the prevailing dull conditions.

MIDLANDS.—With several consumers working short time, prospects in this area are not bright. Stocks are accumulating all round and a long time must inevitably elapse before a return to full-scale production is made. While new business in ordinary foundry iron is extremely quiet, some activity is reported in low-phosphorus iron, although, here again, conditions are still unsatisfactory. The price ranges from £6 2s. 6d. to £7 2s. 6d. per ton, delivered the Midlands. Refined pig-iron at £8 5s. per ton is not receiving many inquiries. There is a little better demand for hematite, which it is hoped will be extended.

SCOTLAND.—No improvement is noted among consumers of foundry iron and stocks are already too high for their requirements. Local steelworks are taking up hematite and basic in heavy tonnages, but their needs have been well covered ahead. No. 1 foundry iron is quoted at 120s. 6d., with No. 3 at 118s., f.o.t. furnaces. Hematite mixed numbers are quoted at 133s., with Scottish basic at 107s. 6d. and English and Indian basic at 100s., all less 5s. rebate and delivered f.o.t. steelworks here.

Coke

Supplies of coke have become more freely available in recent months in the Midlands as a result of the building of several new batteries of ovens and a decline in the demand both on home and export account. Prices are easier in some instances, but prices of foundry coke are maintained, and Durham and Welsh makers state that no change will be made before the end of the year. For delivery in Birmingham and district Durham foundry coke is quoted at 55s. 9d. and Welsh foundry coke at 55s. to 62s. 6d.

Steel

Business in the steel market continues quiet, and for the most part consumers are working on the considerable stocks which have accumulated recently, together with the deliveries they are receiving against running contracts. The large quantities of steel which are passing into consumption, however, should soon make an impression on these quantities, and a revival in demand should then take place. A certain amount of business is passing in small parcels, and this trade may be expected to develop as the season progresses. Business in semi-finished steel is on a smaller scale than for a long period, owing to the recent heavy importations. There is a good demand for certain qualities of British-made semis, but the production of ordinary descriptions has been slowed down for a time until the tonnage on hand has been reduced. In the finished materials section of the market, the demand has been somewhat irregular and the lighter branches of the industry are not so well off for work as are the heavy steel makers. There are signs, however, that more business is stirring than recently, and the acceleration of the rearmament programme should result in increased activity in this section.

Scrap

The steelworks remain the chief source of scrap consumption, but, as a result of a decline in the production of steel, steelmakers are not renewing contracts, at any rate on such a scale as previously. Reports from all areas indicate that the supply of scrap is well in excess of the demand.

Metals

A very nervous and uncertain tone has set in and prices, especially of tin, have fluctuated considerably during the past week or ten days.

Copper.—While the adverse Wall Street advices must be held partly responsible for the unsettled condition of the market, the general tone is weak and business has been very subdued. The Soviet Union has been in the market, but, otherwise, consumers have remained aloof. The requirements of the armament makers appear to be less, despite the proposals to accelerate operations in this section.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £37 17s. 6d. to £37 18s. 9d.; Friday, £38 5s. to £38 6s. 3d.; Monday, £38 18s. 9d. to £39; Tuesday, £38 8s. 9d. to £38 10s.; Wednesday, £38 11s. 3d. to £38 12s. 6d.

Three Months.—Thursday, £38 2s. 6d. to £38 3s. 9d.; Friday, £38 10s. to £38 11s. 3d.; Monday, £39 3s. 9d. to £39 5s.; Tuesday, £38 12s. 6d. to £38 13s. 9d.; Wednesday, £38 16s. 3d. to £38 17s. 6d.

Tin.—After a spell of comparatively steady prices, quotations have now become very unstable. Demand from consumers in this country is quiet; the tinplate industry in South Wales, which is one of the chief consumers, is in an unsatisfactory condition and operation is around 44 per cent. of normal capacity. A dull tone also prevails in the United States, but some improvement was noted following a reduction in prices.

The total visible supply of tin on March 31 was 18,037 tons, against 16,402 tons on February 28, according to the statistics compiled by Mr. W. H. Gartsen (Henry Rogers, Sons & Company). The carry-over in the Straits Settlements on the same dates was 6,469 tons and 4,650 tons, while the carry-over at the Arnhem (Holland) smelter was 2,617 tons and 2,256 tons. When these figures are added together the total visible supply increased from 23,308 tons to 27,123 tons during the month.

Official quotations were as follow :—

Cash.—Thursday, £167 10s. to £167 15s.; Friday, £171 to £171 5s.; Monday, £173 15s. to £174; Tuesday, £168 to £168 5s.; Wednesday, £169 to £169 10s.

Three Months.—Thursday, £167 10s. to £167 15s.; Friday, £167 10s. to £167 15s.; Monday, £174 to £174 10s.; Tuesday, £168 10s. to £168 15s.; Wednesday, £169 15s. to £170.

Spelter.—Japan has taken up quite substantial tonnages recently and it is believed that the supply of zinc in that country is very low. Generally, business has been weak and only the brassmakers have shown inclination to negotiate for further tonnages.

Daily market prices :—

Ordinary.—Thursday, £13 16s. 3d.; Friday, £13 11s. 3d.; Monday, £13 15s.; Tuesday, £13 10s.; Wednesday, £13 13s. 9d.

Lead.—There is little to enthuse over in this metal and not much new business is being transacted. Cable and battery concerns are well employed, but most other consuming plants are unsatisfactorily engaged. World production of lead during February, as reported by the American Bureau of Metal Statistics, was 147,300 tons, compared with 159,000 tons in January.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £15 13s. 9d.; Friday, £15 11s. 3d.; Monday, £16; Tuesday, £15 12s. 6d.; Wednesday, £15 10s.

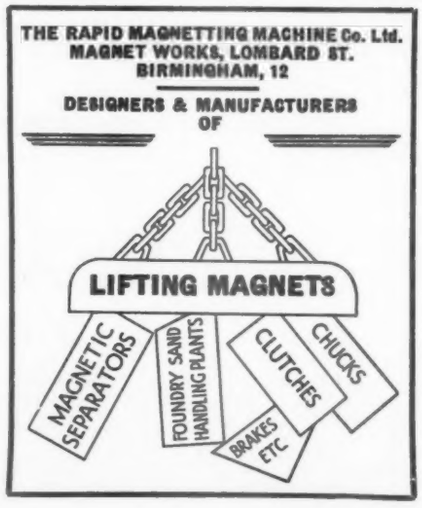
Scrap.—Hand-to-mouth buying continues to be practically the sole source of activity, and consumers are refraining from entering into forward contracts. Prices remain unchanged.

Approximate selling prices for old metal:—New aluminium cuttings, £80; rolled, £63; cast, £38; foil, £88. Copper, £36 to £38; braziery, £32 to £33. Brass (clean), £23 to £24. Zinc, £7 10s. Lead, £12. Gunmetal, £36 to £38.

Publication Received

Starting Young Workers Safely in Industry. Published by the National Safety First Association, Terminal House, 52, Grosvenor Gardens, London, S.W.1. Price 9d. net.

The first part of this book, which discloses the nature of the problem of eliminating accidents to the industrial neophyte, is quite good, but for the rest there is a complete failure to generalise intelligently. At one time the author (or as we suspect authors) has an engineering establishment in mind, and a little later the mining industry. There must be some basic principles which either a colliery manager or the owner of a country jobbing foundry could equally well apply so as to make the introduction of an entrant into industry as free from accidents as possible. These factors are disclosed but scattered, and they require assembling and logical expression. They appear to us to be:—(1) Ascertain that the place of working, its surroundings and the plant are safe; (2) acquire as complete knowledge as possible of the home atmosphere of the entrant, so that the incidence of domestic upheavals can be prevented from being a cause of accident; (3) familiarise the entrant with the work undertaken by the employing firm, and (4) give a balanced tuition on safety-first, and if possible instruction in First Aid should be afforded. Too much safety-first propaganda may kill initiative, but contact with even the elementary medical kit in a small establishment forms a better background than staring at inartistic and often gruesome posters. (5) Keep the beginner busy, as idleness creates mischief and causes accidents. If conclusions were drawn from the foundry industry, embracing as it does large quantity-production establishments down to man-and-boy concerns, they would probably have been generally applicable, but a concentration of thought on machine and press shops and mines has made the report too diffuse and introductory in character.



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RAW MATERIALS—PRICE LIST

(Wednesday, April 6, 1938)

COPPER

	£	s.	d.
Standard cash	38	11	3
Three months	38	16	3
Electrolytic	43	0	0
Tough	41	10	0
Best selected	42	0	0
Sheets	73	0	0
India	54	12	6
Wire bars	43	5	0
Ingot bars	43	5	0
H.C. Wire rods	46	15	0
Off. av. cash, Mar.	39	16	4 29/48
Do., 3 mths., Mar.	40	0	11 17/48
Do., Sttlmnt., Mar.	39	16	7 11/23
Do., Electro, Mar.	44	0	1 7/23
Do., B.S., Mar.	43	18	7 1/3
Do., Wire bars, Mar.	44	8	7 1/23
Solid drawn tubes			12½d.
Brazed tubes			12½d.
Wire			8d.

BRASS

Solid drawn tubes	11d.
Brazed tubes	13d.
Rods, drawn	8½d.
Rods, extd. or rlld.	6½d.
Sheets to 10 w.g.	8½d.
Wire	8½d.
Rolled metal	7½d.
Yellow metal rods	6¼d.

TIN

	£	s.	d.
Standard cash	169	0	0
Three months	169	15	0
English	169	0	0
Bars	171	0	0
Straits	170	10	0
Eastern	176	15	0
Banca (nom.)			—
Off. av. cash, Mar.	183	11	8 21/23
Do., 3 mths., Mar.	183	12	8 1/23
Do., Sttlmt., Mar.	183	11	1 1/23

SPELTER

	£	s.	d.
Ordinary	13	13	9
Remelted	11	0	0
Hard	10	15	0
Electro, 99.9	17	18	9
English	14	15	0
India	13	0	0
Zinc dust	18	17	6
Zinc ashes	5	0	0
Off. aver., Mar.	14	8	4 5/23
Aver., spot, Mar.	14	7	3 9/23

LEAD

	£	s.	d.
Soft foreign, ppt.	15	10	0
Empire (nom.)	16	8	9
English	17	15	0
Sheets, home	23	10	0
Do. export	19	12	6
Pipes, home	23	0	0
Do. export	20	5	0
Tea lead	32	0	0
Off. aver., Mar.	16	0	7 3/4
Aver., spot, Mar.	15	19	10 1/23

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

	£	s.	d.		£	s.	d.
Zinc sheets, English	28	5	0	to 28	15	0	
Do., V.M. ex-whse.	28	5	0	to 28	15	0	
Rods				20	0	0	

ANTIMONY

	£	s.	d.		£	s.	d.
English	81	0	0	to 82	0	0	
Chinese, ex-whse.				67	0	0	
Crude, c.i.f.				40	0	0	

QUICKSILVER

	£	s.	d.
Quicksilver	12	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS

	£	s.	d.		£	s.	d.
Ferro-silicon—							
25%	12	10	0				
45/50%	12	0	0				
75%	17	0	0				
Ferro-vanadium—							
35/50%				14/- lb. Va.			
Ferro-molybdenum—							
70/75% carbon-free				4/9 lb. Mo.			
Ferro-titanium—							
20/25% carbon-free				9d. lb.			
Ferro-phosphorus, 20/25%				£21 to £22			
Ferro-tungsten—							
80/85%				5/6 lb.			
Tungsten metal powder—							
98/99%				5/7½ lb.			
Ferro-chrome—							
2/4% car.	34	15	0				
4/6% car.	24	5	0				
6/8% car.	24	0	0				
8/10% car.	24	0	0				
Ferro-chrome—							
Max. 2% car.	36	0	0				
Max. 1% car.	38	5	0				
Max. 0.5% car.	41	0	0				
70% carbon-free	10d. lb.						
Nickel—99.5/100%	£180 to £185						
"F" nickel shot	£165	0	0				
Ferro-cobalt, 98/99%	8/6 to 8/9 lb.						
Metallic chromium—							
96/98%	2/5 lb.						
Ferro-manganese—							
76/80% loose	£18	15	0	to 19	5	0	
76/80% packed	£19	15	0	to 20	5	0	
76/80% export	£22	0	0				
Metallic manganese—							
94/96% carbon-free	1/3 lb.						

Per ton unless otherwise stated, basis 2-ton lots.

SCRAP

South Wales (West)—	£	s.	d.		£	s.	d.
Heavy steel, best	3	8	9	to 3	11	3	
Mixed iron and steel	3	6	9	to 3	9	3	
Heavy cast iron	3	8	9	to 3	11	3	
Good machinery	3	12	6	to 3	15	0	
Cleveland—							
Heavy steel, best	3	7	0	to 3	9	6	
Steel turnings	2	13	0	to 2	15	6	
Heavy cast iron				4	0	0	
Heavy machinery				4	5	0	
Midlands—							
Short heavy steel				3	12	6	
Light cast-iron scrap				3	2	6	
Heavy wrought iron	4	0	0	to 4	5	0	
Steel turnings	2	6	3	to 2	8	9	
Scotland—							
Heavy steel, best	3	5	0	to 3	7	6	
Ordinary cast iron	4	0	0	to 4	2	6	
Cast-iron borings	2	0	6	to 2	3	0	
Wrot-iron piling	4	5	0	to 4	7	6	
Heavy machinery				4	6	6	

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	31	0	0
Brass	21	10	0
Lead (less usual draft)	14	0	0
Tea lead	10	0	0
Zinc	7	0	0
New aluminium cuttings	69	0	0
Braziery copper	28	0	0
Gunmetal	31	0	0
Hollow pewter	130	0	0
Shaped black pewter	90	0	0

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	3s. 0d.
Finished bars, 18% tungsten	3s. 10d.

Per lb. d/d buyers' works.

PIG-IRON*

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	111/6
„ No. 3	109/-
„ No. 4	108/-
Forge No. 4	108/-
Hematite No. 1	133/-
Hematite M/Nos.	132/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	133/-
„ d/d Birm.	144/6
Malleable iron d/d Birm.	160/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	110/-
„ No. 3 fdry.	111/-
Northants forge	107/6
„ fdry. No. 3	108/6
„ fdry. No. 1	111/6
Derbyshire forge	110/-
„ fdry. No. 3	111/-
„ fdry. No. 1	114/-
Scotland—	
Foundry, No. 1, f.o.t.	120/6
„ No. 3, f.o.t.	118/-
Cleveland No. 3, Glasgow	112/-
„ „ Falkirk	109/-
Scottish hem. M/Nos. d/d	133/-
Sheffield (d/d district)—	
Derby forge	107/6
„ fdry. No. 3	108/6
Lincs forge	107/6
„ fdry. No. 3	108/6
W.C. hematite	138/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	114/-
Staffs fdry. No. 3	114/-
Northants fdry. No. 3	112/6
Cleveland fdry. No. 3	114/-
Glengarnock, No. 3	141/-
Clyde, No. 3	141/-
Monkland, No. 3	141/-
Eglinton, No. 3	141/-
Gartsherrie, No. 3	141/-
Shotts, No. 3	141/-

(* Prices of hematite and basic pig-iron, and of foundry and forge iron with a phosphoric content of not less than 0.75 per cent., are subject to a rebate of 5s. per ton under certain conditions.)

FINISHED IRON AND STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel sections, plates and joists is obtainable in the home trade under certain conditions.]

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	13	5	0	to 13	15	0	
Nut and bolt iron	11	12	6	to 12	2	6	
Hoops				14	2	6	
Marked bars (Staffs) f.o.t.				15	15	0	
Gas strip				14	2	6	
Bolts and nuts, ¾ in. × 4 in.				17	10	0 and up	
Steel—							
Plates, ship, etc.	11	8	0	to 11	10	6	
Boiler plts.	11	18	0	to 12	0	6	
Chequer plts.				13	0	6	
Angles				11	0	6	
Tees				12	0	6	
Joists				11	0	6	
Rounds and squares, 3 in. to 5½ in.				12	0	6	
Rounds under 3 in. to ¾ in. (untested)				11	9	0	
Flats—8 in. wide and over				11	5	6	
„ under 8 in. and over 5 in.				11	10	6	
Rails, heavy				10	2	6	
Fishplates				14	2	6	
Hoops (Staffs)				12	4	0	
Black sheets, 24g. (4-t. lots)				15	15	0	
Galv. cor. shts. („)				18	10	0	
Galv. flat shts. („)				19	0	0	
Galv. fencing wire, 8g. plain				20	5	0	
Billets, soft, 100-ton lots				7	17	6	
Sheet bars				7	15	0	
Tin bars				7	15	0	

PHOSPHOR BRONZE

Per lb. basis

Strip	10½d.
Sheet to 10 w.g.	11d.
Wire	12½d.
Rods	13d.
Tubes	18½d.
Castings	15d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop. £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	8d. to 1/2
Rolled—	
To 9 in. wide	1/2 to 1/8
To 12 in. wide	1/2½ to 1/8½
To 15 in. wide	1/2½ to 1/8½
To 18 in. wide	1/3 to 1/9
To 21 in. wide	1/3½ to 1/9½
To 25 in. wide	1/4 to 1/10
Ingots for spoons and forks	8d. to 1/4½
Ingots rolled to spoon size	11d. to 1/7½
Wire round—	
to 10g.	1/5½ to 2/0½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/4½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	25.84
No. 2 foundry, Valley	24.00
No. 2 foundry, Birm.	20.38
Basic, Valley	23.50
Malleable, Valley	24.00
Grey forge, Valley	23.50
Ferro-mang. 80%, seaboard	102.50
O.-h. rails, h'y, at mill	42.50
Billets	37.00
Sheet bars	37.00
Wire rods	47.00
	Cents.
Iron bars, Chicago	2.40
Steel bars	2.45
Tank plates	2.25
Beams, etc.	2.25
Skelp, grooved steel	2.10
Steel hoops	2.40
Sheets, black, No. 24	3.15
Sheets, galv., No. 24	3.80
Wire nails	2.75
Plain wire	2.90
Barbed wire, galv.	3.40
Tinplates, 100-lb. box	$5.35

COKE (at ovens)

Welsh foundry	42/6
„ furnace	34/6
Durham foundry	39/6
„ furnace	32/6
Scottish foundry	42/6
„ furnace	40/-

TINPLATES

f.o.b. British Channel ports.

I.C. cokes	20×14 per box	22/6
„	28×20 „	45/-
„	20×10 „	32/4
„	18¾×14 „	23/5
C.W.	20×14 „	20/-
„	28×20 „	42/6
„	20×10 „	28/8
„	18¾×14 „	20/9

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.		£	s.	d.
Pig-iron	£11	0	0	to £12	0	0	
Bars-hammered, basis	£20	0	0	to £22	0	0	
Bars and nail-rods, rolled, basis	£19	0	0	to £20	0	0	
Blooms	£18	0	0	to £19	0	0	
Keg steel	£30	0	0	to £35	0	0	
Faggot steel	£20	0	0	to £25	0	0	
Bars and rods dead soft st'l	£19	0	0	to £20	0	0	

All per English ton, f.o.b. Gothenburg [Subject to an exchange basis of Kr. 19.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

			£	s.	d.		
Mar.	31	..	37	17	6	dec.	3/9
Apr.	1	..	38	5	0	inc.	7/6
,,	4	..	38	18	9	,,	13/9
,,	5	..	38	8	9	dec.	10/-
,,	6	..	38	11	3	inc.	2/6

Electrolytic Copper

			£	s.	d.		
Mar.	31	..	41	15	0	inc.	5/-
Apr.	1	..	42	10	0	,,	15/-
,,	4	..	42	15	0	,,	5/-
,,	5	..	42	10	0	dec.	5/-
,,	6	..	43	0	0	inc.	10/-

Standard Tin (cash)

			£	s.	d.		
Mar.	31	..	167	10	0	dec.	110/-
Apr.	1	..	171	0	0	inc.	70/-
,,	4	..	173	15	0	,,	55/-
,,	5	..	168	0	0	dec.	115/-
,,	6	..	169	0	0	inc.	20/-

Tin (English ingots)

			£	s.	d.		
Mar.	31	..	167	10	0	dec.	110/-
Apr.	1	..	171	0	0	inc.	70/-
,,	4	..	173	15	0	,,	55/-
,,	5	..	168	0	0	dec.	115/-
,,	6	..	169	0	0	inc.	20/-

Spelter (ordinary)

			£	s.	d.		
Mar.	31	..	13	16	3	No	change
Apr.	1	..	13	11	3	dec.	5/-
,,	4	..	13	15	0	inc.	3/9
,,	5	..	13	10	0	dec.	5/-
,,	6	..	13	13	9	inc.	3/9

Spelter (Electro, 99.9 per cent.)

			£	s.	d.		
Mar.	31	..	17	12	6	No	change
Apr.	1	..	17	10	0	dec.	2/6
,,	4	..	17	13	9	inc.	3 9
,,	5	..	17	15	0	,,	1/3
,,	6	..	17	18	9	,,	3/9

Lead (soft foreign, prompt)

			£	s.	d.		
Mar.	31	..	15	13	9	dec.	5/-
Apr.	1	..	15	11	3	,,	2/6
,,	4	..	16	0	0	inc.	8/9
,,	5	..	15	12	6	dec.	7/6
,,	6	..	15	10	0	,,	2/6

Lead (English)

			£	s.	d.		
Mar.	31	..	17	15	0	dec.	5/-
Apr.	1	..	17	15	0	No	change
,,	4	..	18	0	0	inc.	5/-
,,	5	..	17	15	0	dec.	5/-
,,	6	..	17	15	0	No	change

AVERAGE MONTHLY PRICES OF STEEL SHIP ANGLES (NORTH OF ENGLAND).

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1903	5 6 3	5 6 3	5 7 6	5 12 6	5 12 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 0 0	5 8 9
1904	5 0 0	4 17 6	5 2 6	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 0 0	5 0 0	5 0 0	5 5 0	5 2 6
1905	5 5 0	5 7 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 12 6	6 2 6	6 12 6	6 12 6	5 14 4½
1906	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	7 2 6	6 13 4
1907	6 17 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	6 12 6	6 12 6	7 0 5
1908	6 2 6	6 2 6	6 2 6	5 17 6	5 17 6	5 17 6	5 17 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 16 3
1909	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 9 7
1910	5 16 3	5 17 6	5 17 6	6 1 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 7 6	6 7 6	6 7 6	6 2 3½
1911	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 9 0	6 7 8½
1912	6 16 3	6 17 6	6 17 6	7 5 0	7 7 6	7 7 6	7 7 6	7 12 6	7 12 6	7 14 6	7 14 6	7 17 6	7 7 4½
1913	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 11 6	7 7 6	6 15 6	6 7 6	6 2 6	7 8 11½
1914	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	5 15 0	5 15 0	6 15 0	7 0 0	7 0 0	7 1 3	7 5 0	6 8 7½
1915	7 17 0	8 5 0	8 17 6	9 5 0	9 5 0	9 15 0	9 15 0	9 15 0	9 15 0	9 15 0	10 15 0	10 15 0	9 8 3½
1916	11 3 1½	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1917	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1918	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6½
1919	11 2 6	13 12 6	13 12 6	13 12 6	17 2 6	17 1 3	17 0 0	17 15 0	17 15 0	17 15 0	17 17 6	18 5 0	16 1 9
1920	19 10 0	20 0 0	21 10 0	22 0 0	23 5 0	24 0 0	24 0 0	24 0 0	24 15 0	24 10 0	24 0 0	24 0 0	22 19 2
1921	22 10 0	20 12 6	19 0 0	17 10 0	17 10 0	16 6 0	14 10 0	14 3 4	13 10 0	11 15 0	10 0 0	9 12 6	15 11 7
1922	9 17 6	10 0 0	10 0 0	10 0 0	10 0 0	9 17 6	9 10 0	8 15 7½	8 14 0	8 12 6	8 12 6	8 12 6	9 7 8½
1923	8 18 1½	9 1 3	9 14 0	10 0 0	10 0 0	10 0 0	9 8 9	9 9 6	9 10 0	9 8 9	9 11 6	9 18 9	9 11 8½
1924	10 0 0	9 18 1½	9 17 6	9 17 6	9 17 2	9 11 3	9 15 0	9 15 0	9 9 4½	9 6 6	9 5 0	9 5 0	9 13 1½
1925	9 2 0	9 0 11½	9 0 0	8 15 9	8 10 3½	8 9 0½	8 6 3	8 2 6	7 19 0½	7 12 3	7 5 0	7 2 6	8 5 5½
1926	7 2 6	7 2 6	7 2 6	7 3 4	7 2 6	7 3 9	7 7 6	7 8 5½	7 9 0	7 12 6	7 16 3	8 0 6	7 7 7½
1927	7 18 9	7 17 6	7 17 6	7 14 8½	7 13 9	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 14 1½
1928	7 12 6	7 14 9	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 16 10½
1929	7 17 6	7 17 6	7 17 6	7 17 6	8 0 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 5 0	8 0 10½
1930	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1931	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1932	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1933	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1934	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1935	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1936	8 7 6	8 7 6	8 7 6	8 7 6	8 10 7½	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 7	8 15 1½
1937	9 3 0	9 3 0	9 3 0	9 3 0	11 0 6	11 0 6	11 0 6	11 0 6	11 0 6	11 0 6	11 0 6	11 0 6	10 8 0
1938	11 0 6	11 0 6	11 0 6	—	—	—	—	—	—	—	—	—	—

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK

FOR EVERY TYPE OF CASTING

NON-FERROUS METALS

REFRACTORIES — COKE — SAND

FERRO-SILICON—FERRO-CHROME

WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

Notice

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

FOREMAN or Assistant desires change. Age 32. Experienced green, dry sand, jobbing, repetition. Ordinary high-duty cast iron. Machine tools; general engineering. First-class references. Guaranteed to get results.—Box 858, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY MANAGER desires change, at present engaged in foundry taking in all types of general engineering castings; mechanised plant, iron and non-ferrous, pattern-shop. Fully capable of taking entire charge, and guarantee results. Age 40. Go anywhere.—Box 878, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY MANAGER, thoroughly practical, 12 years' management of iron foundries, machine, bench and floor production of castings, desires change. Will invest capital in foundry extending business.—Box 876, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

ASSISTANT FOREMAN, experienced pump and engine castings. Full knowledge modern machine moulding and pattern design for production work. Also energetic Pattern-maker.—Apply Box 866, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2

FOUNDRY FOREMAN required for small general foundry in East Anglia. Applicant must have knowledge of machine-moulding as well as general practice, and be able to take complete charge. Applications, which will be treated with strict confidence, stating age, experience, and salary required to: Box 860, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY SUPERINTENDENT required with first-class experience in the production of light castings, knowledge of bath castings and enamelling practice would be an advantage. This position calls for a man who can handle labour, and also possesses tact and energy. Progressive salary and every opportunity for advancement. Apply giving fullest particulars of experience and salary required.—Managing Director, Bilston Foundries, Ltd., Highfields, Bilston, Staffs.

IRON MOULDERS, Brass Moulders, Core Maker, Furnace Man—wanted for a new foundry opening in about a month's time. Write stating experience, wages, etc., to: H. C. Hopper (Surbiton), Ltd., 234, Raeburn Ave., Surbiton.

LEADING jobbing Ironfounders in Midlands, making some of the heaviest engineering castings in the trade, require energetic youth as Special Apprentice. Applicant should be 17/18 years of age, and must have already shown interest in foundry work. Thorough practical training will be given, and special facilities offered for person appointed to be under the constant personal supervision of Foundry Manager. This is a unique opportunity for an ambitious youth to gain the experience necessary for a supervisory position in the foundry trade, and duties of person appointed will be arranged with that object in view.—Write Box 870, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

LONDON Firm requires Bath Expert. First-class experience in all branches of bath manufacture essential. Generous remuneration to right man. Write in confidence.—Box 864, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

SITUATIONS VACANT AND WANTED—*Contd.*

FOUNDRY FOREMAN required for general foundry in the Midlands. Applicant must have first-class knowledge of machine moulding as well as up-to-date general practice. The work consists largely of high-class machine-tool and Diesel-engine castings. Applications will be treated in strict confidence. Apply stating age, experience, and salary required to: Box 874, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

MANAGER required for Iron and Brass Foundry, Pattern Makers and Engineers and Gear Cutters. Must be a live man; if able to introduce business an asset. Write only first, stating experience, salary, etc., to: H. C. Hopper (Surbiton), Ltd., 234, Raeburn Ave., Surbiton.

METALLURGIST required in South of England, capable of research and development in heat-treatment processes. Must be conversant with latest practice in all forms of industrial heat-treatment, including atmosphere plant and control. Recognised degree in metallurgy desirable but not essential. Progressive position for energetic individual with initiative. Applicants are invited to write stating age, experience, qualifications, and salary required to: "E.R.," c/o Streets, 6, Gracechurch Street, London, E.C.3.

WANTED.—A Foundryman or Metallurgist with good experience in cast iron and who is willing to travel. Applicants should give age, experience, and salary required.—Box 880, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2

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NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. Davies & Son, West Gorton, Manchester.

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